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MINING AND RAILWAY DEVELOPMENT IN PERU.

By G. Fred. Collins.

In considering the commercial consequences of the opening of the Panama Canal, the relations of Europe and the United States to the Pacific coast of North America and to the Far East have been most conspicuous in the public mind. The greatly improved access to the nations of the Pacific coast of South America, however, is very important, and it is certain that among the first commercial results of the piercing of the waterway will be the development of Peru and its neighboring republics. Mr. Collins writes from a large experience gained in many visits to all parts of South America—visits including protracted residence and successful commercial relations; and his observations and his information are all acquired at first hand, and supplemented by many unique photographs.—THE EDITORS.

THE opening of the Panama Canal will be one of the great events in the history of the Western hemisphere, as it will place the Pacific coast of South America in closer communication, by steamers direct, with the United States. Peru, the home of the ancient Incas, from its location, will be one of the first countries to receive benefit from the construction of the Isthmian waterway. Most of the goods shipped to Peru at this time are sent by steamers from England and Germany, mostly from Hamburg. A great many American exports, even, are sent to Hamburg to be reshipped to Peru, the rates of freight being less by this route than by the steamers which leave New York and go around the Horn to Peru, stopping at other ports en route. Europe and the United States will both be vastly nearer to the west coast of South America when the short passage through the Isthmus, from ocean to ocean, is at last finished.

The trip down the coast from Panama on the comfortable steamers now running between that port and Valparaiso is broken by stops at Guayaquil (Ecuador), Payta and Trujillo (Peru), all interesting

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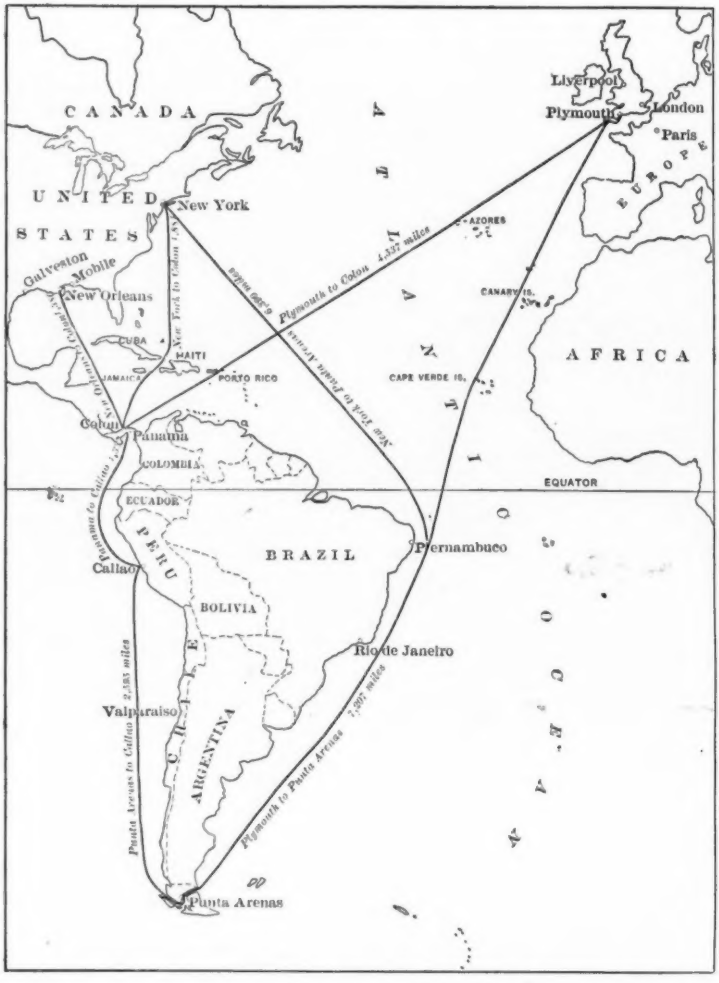


OUTLINE MAP OF (APPROXIMATE) RELATIVE SAILING DISTANCES VIA THE PANAMA CANAL AND THE STRAITS OF MAGELLAN.

It will be noted that the distance from New York to Callao, which is 8,985 miles via the Straits of Magellan, will be reduced to 3,218 miles via the Panama Canal. The distance from Plymouth to Callao will be reduced from 9,802 miles to 5,874. All distances given are expressed in nautical miles.

places. Anchorage in the Bay of Callao is reached generally during the night, and the passenger awakens in the morning to find himself in the chief seaport of Peru. The bay is shut in by the Island of St. Lorenzo, which with its little light house perched high up on one end, looks very commonplace, except when associated with the history of its origin. The island rose from the depths of the Pacific in one night during a frightful earthquake, at which time the old city of Callao was engulfed beneath the waters of the Pacific.

TAKING IN CARGO, PACIFIC COAST, COASTWISE STEAMSHIP.

After passing the custom house at Callao (where one always finds the officials very courteous and polite), passage may be taken by either the English or American Railway for Lima, the capital, which is situated about six miles from the coast; there comfortable accommodations can be found in one of the several good hotels. I must say that in all my experience in traveling through South America, there are no people who give better treatment towards Americans generally than the Peruvians. Their attitude has probably been influenced by the treatment they have received from the United States.

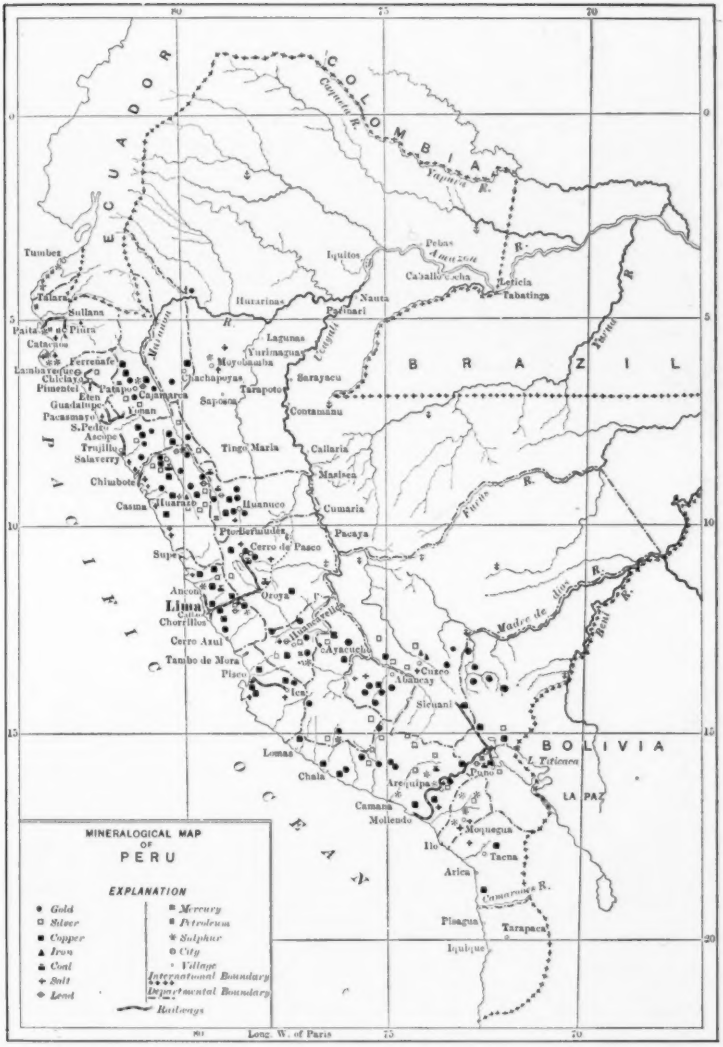
On the west coast, Peru is bounded by the Pacific Ocean, having an extensive coast line of about 1,300 miles. It adjoins on the north the republics of Ecuador and Colombia; on the east, Brazil and Bolivia; and on the south, Bolivia and Chili. The most northern port on the Pacific coast is Tumbez, the first point of landing by the Span-

SHIPPING IN THE HARBOR OF CALLAO.

iards when they came to conquer the country. The boundary line commences a short distance to the north of that port and runs southward as far as the river Macara, following its course to about latitude 5° south, longitude 79° west, whence (according to the line claimed by Peru) it goes in a northeasterly direction by Andoas to Santa Rosa, which is the extreme northern point of Peru. The boundaries between Peru and Bolivia have never been definitely fixed, but it is understood the line follows up the river Beni to the Andes, passing through a

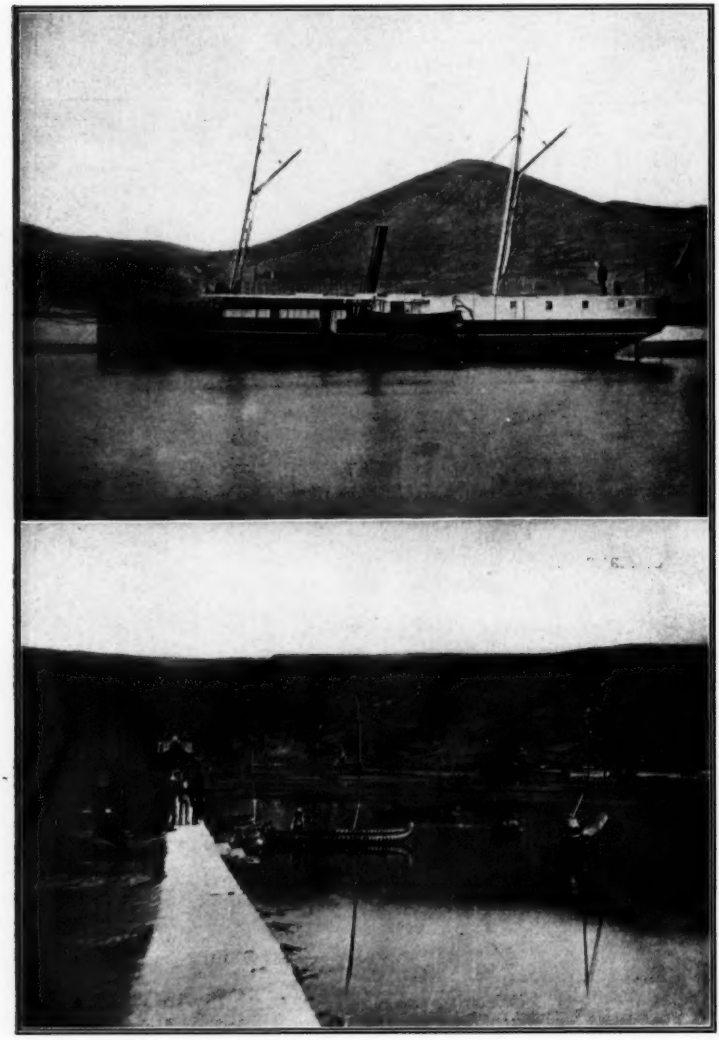
THE PORT OF PARA, BRAZIL, AT THE MOUTH OF THE AMAZON.

The commerce of eastern Peru has a possible outlet by navigable waters of the Amazon to the Atlantic, 3,000 miles from Callao across the continent.



MAP OF PERU, ACCORDING TO A PUBLICATION (1903) OF THE MINISTER OF FOREIGN AFFAIRS.

By this map the northern boundary is pushed out much farther than the line defined by Mr. Collins on page 644. This probably represents the maximum of Peru's territorial claims.



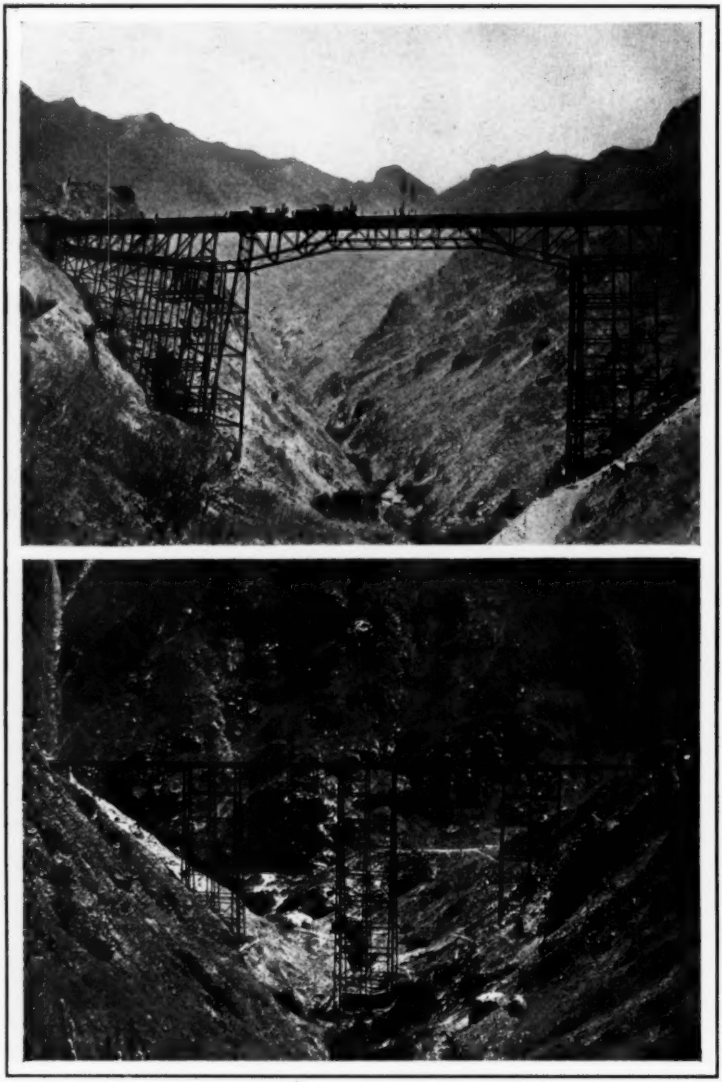
NATIVE AND STEAM CRAFT ON LAKE TITICACA.

The highest body of water in the world navigated by steam. Elevation, 12,545 feet. The only fuel obtainable for the steamboat is dung of the vicuña or guanaco—the llamas of the high altitudes.

THE CITY OF LIMA, FROM SAN CRISTOBAL.

part of Lake Titicaca, and thence follows the Andes till it reaches and descends the river Camarones. The area of the Peruvian territory is about 500,000 square miles, being as large as England, France, Spain and Portugal put together.

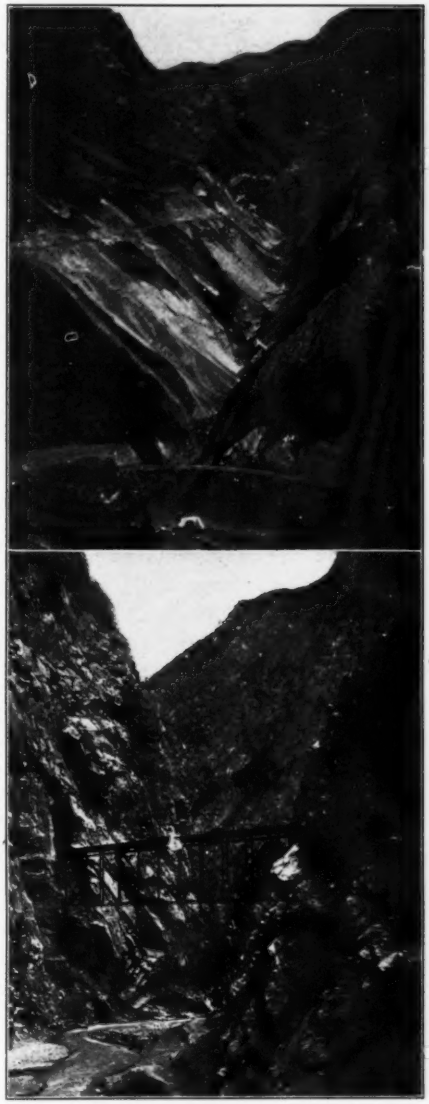
One of the most interesting trips afforded by the present transportation facilities of the country is that over the Oroya Railroad which now runs from Callao to the gold fields of Cerro de Pasco. It is considered one of the wonders in the Peruvian world, and the original contract was taken by Mr. Meiggs at $27,600,000 in bonds at 79. It is certainly the greatest feat of railroad engineering in either hemisphere, and as a specimen of American enterprise and workmanship it suffers nothing by comparison. It was begun in 1870 and finished in 1876, and additional work has since been done on it. Commencing in Callao, it ascends the narrow valley of the Rimac, rising nearly 5,000 feet in the first 46 miles. Thence it goes through the intricate gorges of the Sierras till it tunnels the Andes at an altitude of 15,645 feet, the highest point in the world where a piston rod is moved by steam. The wonder is doubled on remembering that this elevation is reached in 78 miles. One of the most remarkable things in connection with this road is that between the coast and summit there is not an inch of down grade. The difficulties encountered in its construction were extreme—



THE VERRUGAS VIADUCT, BEFORE AND AFTER RECONSTRUCTION.

The lower view shows the earlier form. The cantilever construction was adopted after a flood had taken out the centre pier.

landslides, falling boulders, soroche (or the difficulty of breathing in high altitudes) and verrugas, a disease known only along the line of this road, characterized by a species of warts breaking out all over the body and bleeding. About 8,000 workmen were engaged at one time, and between 7,000 and 8,000 persons died or were killed in the construction of the road. The bridges and crossings, about thirty, are all made of iron or stone; of the metal structures some are of French and some of English manufacture, but the best are American. The Verrugas bridge is one of the most remarkable structures of its kind in the world. It spans a chasm 580 feet wide, and originally rested on three piers. The centre one was destroyed by a water spout, and to prevent repetition of the accident a bridge of cantilever type was constructed to replace the old one, as shown in the photographs. The view was taken during a test of the span.



ON THE OROYA RAILWAY.

LIMA. THE PLAZA AND THE CATHEDRAL.

One of the most exhilarating trips is a ride down the Oroya Railroad on a hand car, drawn by gravity; to fly along the edge of a precipice at the rate of 50 miles an hour, and to go around a curve until every hair of your head stands on end, is glorious—when over. I think that one experience of this kind during a lifetime is enough.

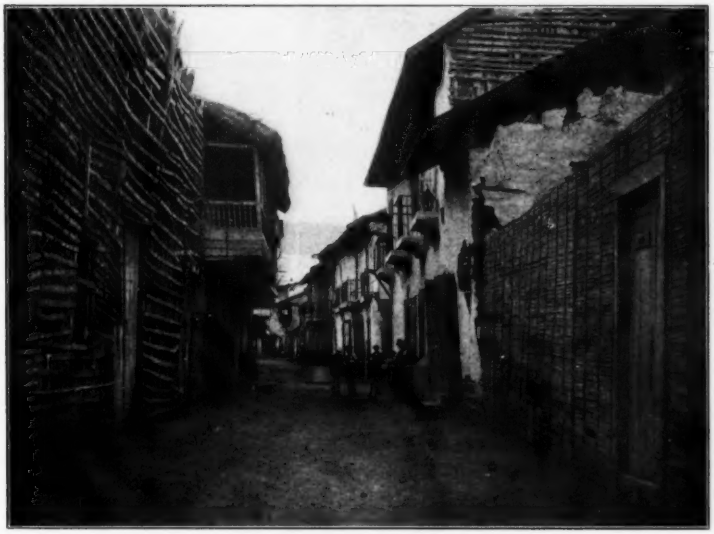
American capital is very largely interested in enterprises in Peru, and it is certain to be more so when a line of steamers is established running direct from New York through the Panama Canal to Callao. The wealth of Peru in precious metals has always been proverbial, and it is sufficient to consult the ancient historians to get some idea of the quantity of gold which the country was reported to possess. The existence of great wealth in the precious metals is shown by the objects of art which were found in the temples of the Incas at Cuzco, Pachacamac, and other places, at the time of the conquest, and also the large amount of gold which Atahuallpa gave for his ransom, at Cajamarca —a room, historians tell us, filled with gold as high as one could reach. Several times during my travels in Peru I have seen men with bottles of gold nuggets which they had found in some of the river beds. The country in the extreme eastern portion of Peru on the rivers forming the headwaters of the Amazon, is, however, very dangerous to white men on account of unhealthy conditions and climate and the prevalence of fevers. The natives also are unfriendly and treacherous.

Silver and copper are mined in large quantities, and the coal de-

posits of the Ancachs department are among the richest in the world. It seems as if nature had designed to give the country, at the same time she endowed it with its magnificent metal mines, the most useful element to enable it to draw profit from them.

There is no question but the output of gold and silver can be very much increased when better facilities are provided by the influx of capital and talent which will follow the establishment of direct communication with the United States and closer touch with England and the Continent.

The necessity for a thorough geological survey, similar (say) to that of the United States, is great, and the mineral wealth it would disclose is unquestionably enormous. The Peruvian Government is actively awake to the opportunities and the needs of the country and is making an earnest effort to put the facts before the engineering and financial interests of the older countries. "Mining in Peru is still in its infancy," says the Minister of Foreign Affairs in a recent publication, "and foreign enterprise is needed, as native capital is insufficient for such great undertakings." "It may be said that the greater part of the mineral products of Peru is exported; very little of it is used in the country, with the exception of small quantities of gold and silver for the mint, and for the manufacture of ornament, etc., and of coal,



MAIN STREET, PAYTA, A NORTHERN COAST CITY OF PERU.

petroleum, salt for domestic uses, and of quicksilver which is employed in amalgamation works." He summarizes the total mineral output of the country in 1900 and 1901 in the following table:—

	Kilogrammes.		Soles.	
	1900	1901	1900	1901
Gold	5,418	6,994	2,232,000	2,500,000
Silver	26,108,015	21,368,352	9,295,755	7,000,000
Copper	35,500,000	25,172,826	6,192,615.36	10,252,500.63
Lead	218,933	114,407	85,116.67	50,123.02
Mercury	11,500	.....	17,500	
Coal	47,500,000	45,000,000	650,000	600,000
Graphite	11,909	.....	1,613	
Sulphur	634	4,120	31.76	412
Borax	7,079,714	4,156,047	566,377.12	332,483.46
Salt	15,000,000	15,849,111	550,000	784,764.20
Sundry	145,551	.....	39,597.50	157,948.94
	131,581,673	111,671,860	19,630,606.35	21,678,323.25

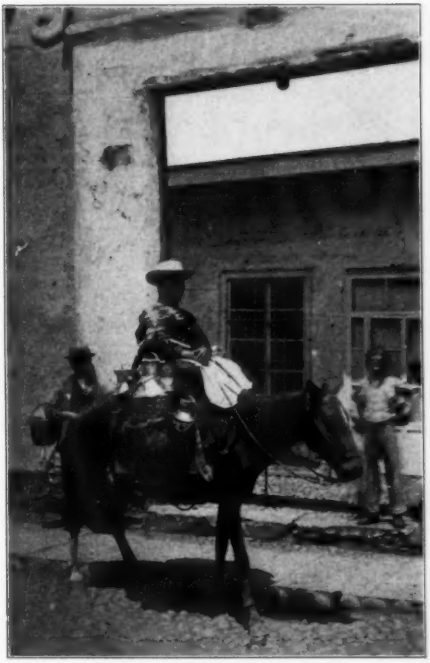
The value of the "sol" is about 24 pence, or 48 cents U. S. currency.

A question of vital importance to outside enterprise seeking opportunity to exploit the undeveloped wealth of Peru would, of course, be the attitude and policy of the Government toward the mining industry. Señor Larrabure y Unanue, the Foreign Minister, thus defines the law and practice of his country:—

A STREET IN LIMA.

The mining industry is open to all, irrespective of nationality. The usual mining claim, or "pertenencia," allowed by the State, is 100 metres in width and 200 metres in length, measured horizontally "in the direction pointed out by the person interested" and extending vertically to indefinite depth. A claim double this size (or four hectares) is allowed in the case of coal, petroleum, and placers of platinum and tin. The maximum of a concession is limited to 70 contiguous pertenencias, but the law does

not prohibit one person from soliciting several grants which are in close proximity to one another. The only tax, except one of 3 per cent. on the exportation of gold in bars and in gold dust, is of 15 soles ($7.50, or £1.10) per pertenencia every six months; miners may transfer their rights, or part of them, without objection. By a law passed November 8, 1890, no new taxes can be imposed on the mining industry or on the exportation of metals for the space of twenty years.

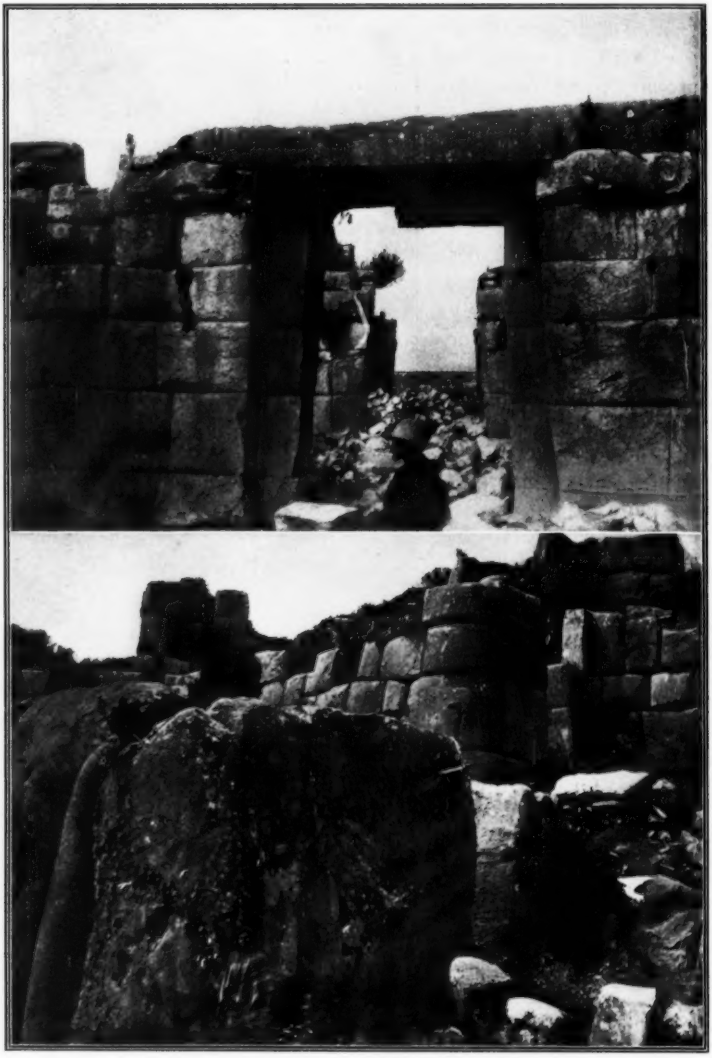


IN THE STREETS OF LIMA.

In the mining centres the miners elect their own "special representatives," familiar with all mining questions, foreigners being eligible to such election. The laws afford all facilities and proceedings are simple and rapid.

There are no other restrictions, except that guano deposits are Government property, and nitrate, borax, and other alkaline salt deposits are subject to special laws. The total number of pertenencias taken up was, in 1880, 1,756. By 1890 this had risen to 3,490, and in 1900 the number had reached 5,178. An idea of the distribution of the mineral wealth is given by the map.

The railway enterprises in Peru are practically at a standstill at the present time. There is however already invested about $150,000,000 in railroads—a large sum for a population of about 4,000,000 people. Almost all the great railroads of the Republic represent the work of Mr. Meiggs, one of the most active representatives of engineering enterprise south of the equator. Mr. Meiggs had contracts with the Government amounting to $133,000,000, for building seven rail-



ANCIENT RUINS AT CUZCO, ONCE THE CAPITAL OF THE INCAS.

The stone behind the Indian in the lower picture is estimated to weigh 360 tons.

TRANSPORTATION IN PERU. LLAMA PACK TRAIN, EN ROUTE TO CUZCO.

roads with an aggregate length of about 1,000 miles. The gauge of the roads is 4 feet 8½ inches, except in the case of that at Chimbote, which is 3 feet. The rolling stock is American, cars coming principally from Gilbert Bush & Co., Troy, N. Y., and locomotives from Rogers, of Paterson, N. J. A locomotive on the track costs about $20,000 to $25,000, and the first-class car $5,500.* The ties are from Oregon, the rails from England, and the diamond drills from America, worked by Rand compressors. The stationary machinery has been imported largely from Leeds, England. The shops and stations generally are made of galvanized iron. The shovels are Ames, and the iron water tanks Pills' patent. The engineers, at least those I met, are invariably English-speaking, and the laborers are Chinese, Cholos, and Chilians. The timber, iron, rolling stock, labor, and fuel, and nearly all of the food, are imported. The train upon which I went over the Oroya road was drawn by a locomotive using crude oil. I rode on the engine over almost the entire system and found that the oil was giving great satisfaction.

I once made a trip up to Cuzco, the ancient capital of the Incas, and there saw the noted fortress of Sacsahuaman, the beauties of which have been described by Squiers in his work on Peru. The photographs

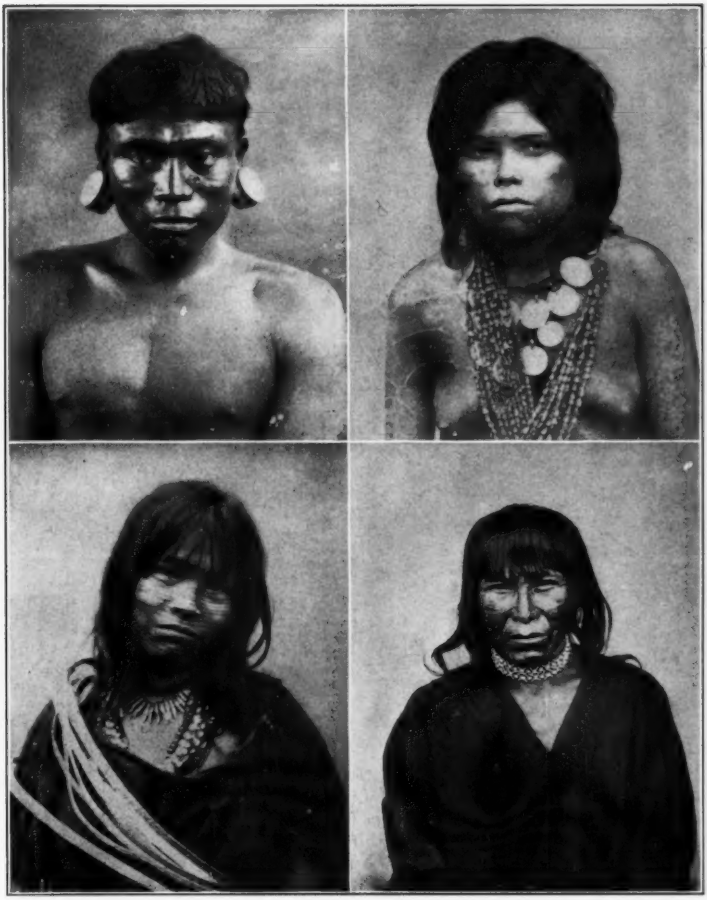
* The prices are in American gold coin.

which are reproduced on page 654 show the size of some of the stones; the one in front of which the Indian is standing is estimated to weigh about 360 tons. It was brought from the quarries about 17½ miles distant, and elevated to the fortress, which is about 800 feet above the town of Cuzco. The Incas must have been able to handle such tremendous weights by methods which have been lost. Unfortunately, a great many of the finest buildings were destroyed by the Spaniards, so that we simply have the ruins to show us what great buildings were originally erected.

CLOISTERS OF THE CATHEDRAL OF CUZCO, BUILT ON THE SITE OF THE ANCIENT TEMPLE OF THE SUN.

The stone which now forms the basin of the fountain in the centre was the altar on which human sacrifices were offered in the time of the Incas.

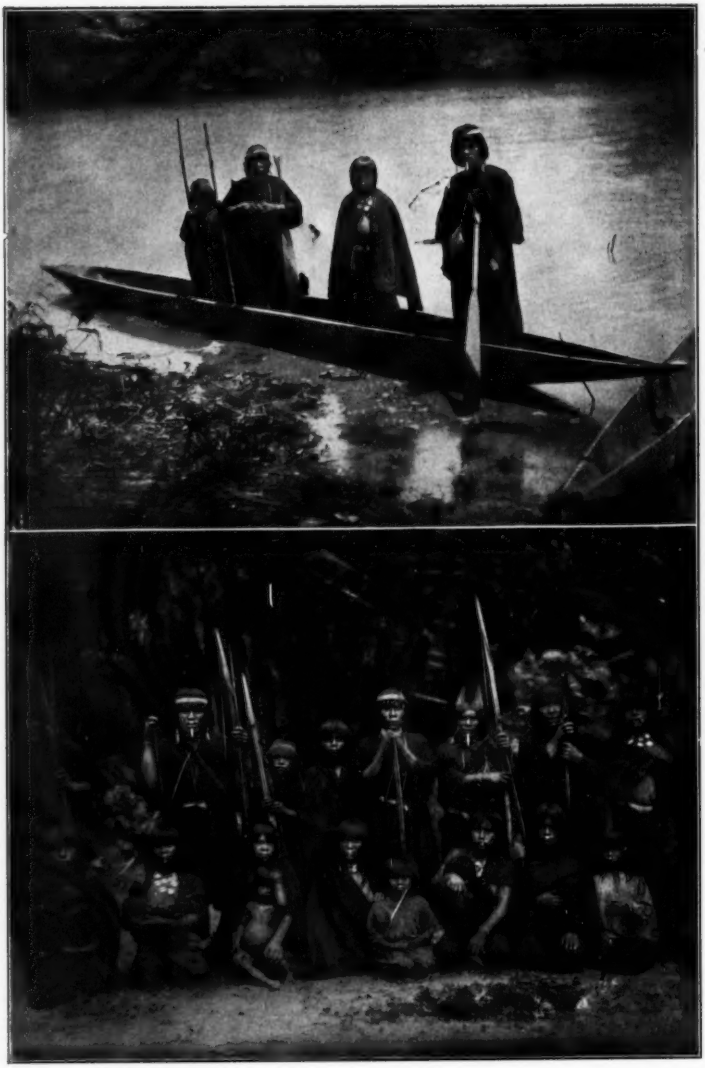
Most interesting subjects for study are found in the various tribes of Indians which occupy the region in the extreme eastern part of Peru, at the headwaters of the Amazon River. The Marugas on the Javary have a dark complexion and light beard; on the west side of the river are the Mayorunas, a fierce, hostile, light-colored tribe of bearded cannibals. The Conibos occupy the extreme north of the territory of the Huillcamayo and part of the prolongation of the Ucayali; the extent



INDIANS OF THE UPPER AMAZON BASIN, PERU.

1. Orejon.
2. Campa.
3. Cashiva (cannibal).
4. Conibo.

of their territory is 246 miles, beginning at the river Simpa and extending to the Capisinia. The land is flat and woody and the atmosphere is humid. The Conibos are small in stature, brown in color; their bodies are fat and almost womanish; their features are proportionate, and they have their noses less flattened than other Indians. The women have ugly faces, and deformity in proportions of the body. The



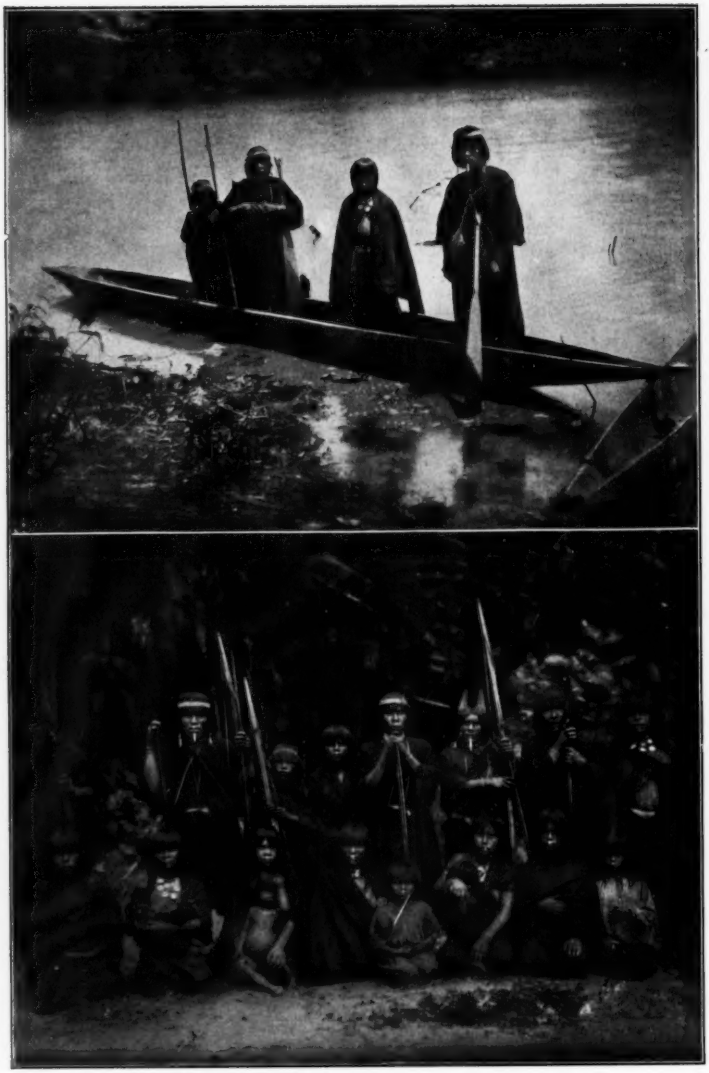
CONIBOS (OR CUNIBOS) INDIANS OF THE UCAYALI RIVER.

Orejon Indians have a peculiar way of putting round discs in their ears, considering it a decoration of beauty.

The Cashiva Indians live on Chonta Island, in the Rio Pachitea; they are cannibals. The decorations seen around the neck of the girl in the illustration are silver soles, or Peruvian dollars. They probably have been stolen from some traveller.

AN INDIAN (DWARF) AND FAMILY—CAJAMARCA.

Professor Orton says: "The valley of the Amazon is probably the most sparsely populated region on the globe. There are not 40,000 souls along the banks of the rivers in the whole of the Amazon and the Maranon. Many of the towns marked on the map do not exist, or are represented by a solitary palm hut. The visible population is almost confined to the circumference of the valley, as at Para at the mouth of the river, at Moyobamba and at Tarapoto. The great basin is filled



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AN INDIAN VILLAGE.

with a continuous, dark, primeval forest, rarely disturbed by the hand of man, and into which daylight seldom enters. Yet imagination peoples this pathless wilderness with uncounted forms of savages. There are, it is true, numerous clans—we can hardly call them tribes—which, though dignified with separate names, are insignificant in numbers, barely numbering 100 each.

"Raimondi puts down the number of all the wild Indians on the Maranon (that is, in the whole province of Loreto which stretches from Ecuador to Cuzco and from the top of the Andes to Brazil), as from 30,000, to 40,000. To this must be added another 40,000 to include the civilized tribes, half castes and whites."

Authors assign to South America from two hundred and eighty to seven hundred languages, of which two-fifths are composed of idioms radically distinct. The polygot America is antipodal to the Chinese. The language of the latter is richer in words, that of the former, the poorer. The preposition follows the noun, and the verb ends the sentence.

TYPE OF THE LORENZO INDIAN.

The hospitality of the Peruvian people is acknowledged by all who have visited Peru. They are also very charitable, as testified by the numerous institutions supported by voluntary contributions. The Peruvian women are well-known for their do-

A "ROAD" IN THE PERUVIAN FOREST, AT THE HEADWATERS OF THE AMAZON.

STREET IN PERUVIAN TOWN. CALLE DE BELEN, IQUITOS.

Iquitos, though well within the western boundaries of Peru, near the headwaters of the Amazon, was visited some years ago by the U. S. gunboat Wilmington, in 1899. According to the reconnaissance survey then made, 14 feet draft can be carried to Nauta at any time. (See map, page 645.)

HOUSE OF A GERMAN SETTLER, RIO PACHITEA.

The family have since been killed by the Indians, and the house destroyed.

mestic attachment and patriotism. Their merits were displayed during the late war with Chili, when they make great sacrifices for their country's sake, giving up not only their money but their jewelry and other valuables. Much has been said, with very good reason, of the beauty of the ladies of Lima. In addition to their unimpeachable morals, they can count amongst them numbers of high literary celebrities. Nature has lavishly endowed them with many of her choicest gifts. In figure they are usually slender and rather tall, and they are especially remarkable for small, elegantly formed feet. Their fair faces are animated by large, bright, dark eyes; their features are pleasing, the nose being well formed, though in general not small, the mouth invariably adorned with brilliant white teeth, and the long black hair arranged in plaits falling gracefully over the bosom and shoulders; add to all this a captivating grace of manner and deportment, joined to an exceeding degree of gentleness and amiability, and it will be readily admitted that the Limeña is a gracious specimen of female loveliness.

In all my travels in South America I never found any people who were so anxious and willing to do business with the United States as the people in Peru. Upon the same terms—or even a little more—they seem to be willing to give the United States the preference, and when the Panama Canal is finished, undoubtedly a large business will be done with the American manufacturers in all classes of goods.

The country there is practically undeveloped. By the help of enterprise and capital, it will advance and prove itself to be, as it is, one of the richest countries in the world.

LINES OF PROGRESS IN THE EFFICIENCY OF THE COMBUSTION MOTOR.

By Edward C. Warren.

Many years ago that master mind in engineering work, the late Sir William Siemens, in the course of his investigations in heat motors, suggested the possibility of maintaining a continuous combustion in a closed chamber at constant pressure, using the whole of the expansive products of combustion for the production of motive power. The success of the four-cycle motor, however, and the diversion of his efforts to other lines of work, left this fertile field undeveloped, and it has remained for later engineers to take up the subject. The early death of Brayton interrupted his practical application of the principle, and until very recently nothing more has been done. Mr. Warren reviews the later efforts of engineers in this line of study, and accompanies it with some suggestions of his own which may lead to interesting practical results.—THE EDITORS.

IN a paper read before the National Electric Light Association at its meeting in Chicago on May 28th, 1903, Prof. Elihu Thomson reviewed the development of the electric-station power plant from its beginning in 1878 down to the year just closed. He pointed out the various stages through which this class of equipment has passed—from the high-speed, belt-driven dynamo of the earlier days to the ponderous, slow-moving direct-connected generating equipment of the Corliss engine type, and more recently the reversal to an extremely high-speed type of electric machine, coupled direct to turbine engines—an outfit representing a radical departure in the matter of dynamo design as extraordinary as the previous rapid development in the direction of slow speeds and heroic dimensions. Prof. Thomson appears to conclude that, as compared to the older types of generating equipment, the steam "turbo-generator" possesses such marked advantages as to insure its adoption to some extent, but proceeds to point out that the recent rapid development in this field of yet another type of prime mover—the gas or oil engine—gives early promise of successful competition with the established occupants of this important field of power development.

However, after making clear the acknowledged tremendous advantage of high thermal efficiency possessed by this type of engine (stated to be fully double that of the best steam-engine plants), and almost venturing the prediction that this is to be the motive power of the future, Prof. Thomson raises a most pertinent and timely question in the following words:—

> "But if the gas engine should ever become a general source of power, what becomes of our driving? Will it be brought again to belting, or some form of gearing-up for increase of speed, or will the heavy, direct-driven dynamo again be found coupled to gas engines, instead of reciprocating steam engines? It is not probable that large gas engines will be run much faster than steam engines of equal power, so that the queries just propounded will need to be answered by future engineering."

Prof. Thomson makes it clear in this connection that the turbine is necessarily restricted to the use of *steam* as its motive fluid, owing to the fact that its efficiency cannot be made satisfactory except when exhausting into a high vacuum—a condition which is manifestly impossible of fulfillment with a non-condensable gas.

Agreeing, as we must, with the conclusions of this learned authority, we are thus confronted with a most embarrassing alternative. It would seem that we must soon make final choice between two widely different systems or methods of heat conversion, each of which possesses a certain series of commanding merits, which, however, seem inseparably associated with equally prominent and distinguishing faults. The various short-comings in either case serve about equally to disqualify both systems for the fulfillment of the ideal conditions demanded for the important work of converting the heat energy of natural fuel into the desired form of mechanical power. On the one hand, we have the newly developed and highly perfected rotary types of prime mover, representing the ideal of mechanical simplicity and functional operation, but grievously handicapped by the inherent deficiencies of their necessary adjunct, the time-honored steam boiler. On the other hand, less intensely interesting from an aesthetic standpoint, but commanding in its sturdily practical capacity for returning a fair equivalent for the fuel consumed, we have the "rational heat motor"—the oil or gas engine—with a net thermal efficiency double that of the steam plant, but embodied in the most primitive form and presenting all of the characteristic and limiting mechanical features of the reciprocating steam engine.

In all the history of the internal-combustion type of prime mover, dating back some two hundred years or more, little consideration appears to have been given to the purely mechanical features of design or to the perfecting of the internal-combustion engine as a machine. In fact, the reciprocating type of engine seems to have been invariably taken as the only available or possible mechanical arrangement of parts to perform the work of converting the heat energy of any expansible medium into work, and hence practically all recorded (or at present known), designs of engines or apparatus for the utilization of the

direct expansive energy of liquid or powdered fuel, are based upon the mechanical cycle of the reciprocating piston. Nevertheless, some noteworthy attempts to vary this cycle of operations for facilitating the attainment of proper conditions of combustion, expansion, and the general conservatism of the heat energy evolved, have been recorded —notably, the "ready motor" developed by Brayton in 1872, in which every consideration of mechanical design and operative excellence seems to have been sacrificed to the attainment of a theoretical heat diagram, and, later, the "differential" gas engine of Atkinson, in 1885, in which the variant extremes of theory and application were well exemplified.

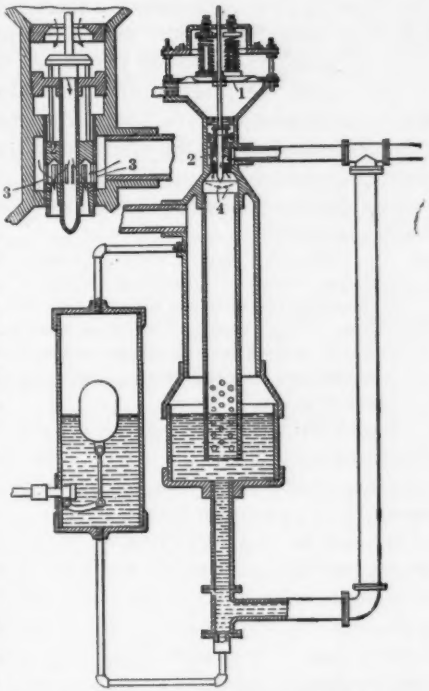
To the somewhat remarkable fact that the reciprocating piston has always been regarded as an essential factor in any method of direct energy conversion, is probably due the idea of primarily compressing the combustible element in order to facilitate combustion. Brayton used a separate reservoir, from which a compressed gaseous mixture was fed into the working cylinder, combustion proceeding slowly and at constant pressure. In the later commercialized gas and gasoline engine of the Otto type, the compression was carried further and made a part of the regular working cycle within the cylinder itself, this arrangement resulting in greater mechanical simplicity and somewhat superior thermal economy, due in large measure to the high pressures which could be employed and the higher piston speed made possible.

The development of modified forms for the use of the less volatile oils as fuel has been marked by the attainment of yet greater thermal economies and some improvement in mechanical design. The kerosene engine of Priestman explodes the vapor generated by atomizing and rarefying the oil prior to admission to the engine cylinder. In the Hornsby-Akroyd type, the fuel is injected as a liquid, vaporized by the heated contents of the cylinder, and exploded by the heat of compression alone, while in the well-known petroleum motor perfected by Herr Rudolph Diesel, we have the compression theory developed to its logical conclusion, and probably the nearest possible approximation to the conditions required by the ideal Carnot cycle.

Prof. Reeve, in 1897, proposed an apparatus for burning liquid fuel continuously, in connection with a water compartment through which the gases of combustion were passed in order to reduce those gases to a condition suitable for use in a steam-engine cylinder. The practical importance of this question of control of temperatures cannot be over estimated; it is of no value to secure perfect combustion and ideal theoretical cycles, if the temperature of the working medium

be so high and the quality of the gases such as to burn out or corrode any available materials of construction.

In the apparatus patented by Bruno V. Nordberg in 1895, this idea is also given consideration, but, as in all similar systems recorded, the difficulties attendant upon the proper proportioning of oil and air under varying engine loads, and other like practical problems, seem to have defeated the commercial application of the idea.



CONSTANT PRESSURE GENERATOR OF PROF. SIDNEY A. REEVE.

The diaphragm 1 actuates the regulating valve 2, shown on enlarged scale on the left. The gas enters at 3, in the centre, and the air around it, the ignition taking place at 4. The float in the auxiliary chamber keeps the water at a constant level.

If the relatively excellent thermal efficiency of the petroleum motor were secured in a mechanical construction comparable with even the standard types of reciprocating steam engine in the essential points of uniform rotative effort upon the driven shaft, cost of construction, weight, bulk, durability, and general operative desirability as a mechanism, it would not be difficult to forecast the immediate future of power generation. The unfortunate fact is however well-known, that engines of this class invariably present mechanical disabilities which go far toward offsetting the practical value of their higher thermal efficiency. This fact has been observed so uniformly that it has come to be almost an accepted conclusion that improved thermal economy can be secured only by a corresponding sacrifice in the direction of mechanical availability in the motor. The mechanical shortcomings of the gas or oil engine seem to be accepted as probably

inevitable, in view of the fact that these types employ a method inherently less wasteful of heat than the alternative method of boiling water by radiation and using the energy second-hand. This thought is even given the sanction of high authority by Prof. Sydney A. Reeve, in his book on "The Thermodynamics of Heat Engines." In a chapter devoted to the consideration of the practical features of first cost and operative efficiency, reference is made to a table showing the relative thermal economy and "builder's cost" of various types of heat motors, as follows:—

> "This table shows clearly, if coupled with the statements of the obstacles arising in attempting to utilize hot air, how those engines of maximum efficiency pay for it in bulk and first cost, and, vice versa, how those of high capacity (low first cost) pay for it in poor efficiency. It will be noticed that all of the engines using permanent gases for working-substance exceed the non-condensing steam engine in cost as well as efficiency."

I hold that this conclusion is not necessarily reasonable or true, and that there is nothing in the history of the art sufficiently indicating the existence of any law which determines that an economical engine, or apparatus or system for the conversion of heat energy into work, must of necessity be of more expensive, or less mechanically rational design or construction, than one less wasteful of heat. There appears, in fact, to be no logical reason why maximum thermal efficiency and maximum mechanical efficiency may not in practice be combined in a mechanical construction of reasonable simplicity, cost, compactness, and weight. The trouble, as previously indicated, appears to be that the modern internal-combustion engine has been built solely upon the primitive reciprocating-piston engine as a foundation, and in the effort to adapt this type of machine to a service which it was not originally designed to perform, the inevitable compromises have been made, all of which have tended to impair, rather than to improve, the essentially unsuitable mechanical design of this type of prime mover.

In this connection, the following from the concluding paragraph of an admirable paper read by Prof. Charles E. Lucke before the American Society of Mechanical Engineers in December, 1901, is of particular interest:—

> "There is one point, however, that should receive notice, that is, should we operate Brayton cycles with intermittent or continuous combustion? With intermittent combustion, the fire burns within the cylinder, and as nothing but fuel and air pass the inlet valves, they can be the more easily kept cool; while, on the other hand, the placing of the burner beyond the valve presents two undesirable features: first, the clearance must be unusually large; and second, the intermittent feed and

> cut-off of air and fuel at just the right time, without alteration of proportion in a fraction of a second, introduces a condition very difficult to meet. Continuous combustion within a fire-box is easier to handle, there being no alterations of feed, and the clearance may be as small as we please, whereas we have as undesirable the feeding of hot gases past the inlet valves."

In the present state of development of the internal-combustion engine, it is undoubtedly true that the gain in thermal efficiency over the steam engine is practically offset by the mechanical limitations and disadvantages which it presents. In the absence of any complete solution of the problem, it remains to choose between the two available, but about equally unsatisfactory, systems of energy conversion. The choice is truly a hard one, but this is a sternly practical age. The cost of fuel must continually rise, and though we may with reluctance admit it, the final choice must inevitably fall to that type of prime mover capable of returning the largest percentage of the precious fuel in the form of useful work. Even now it is being freely predicted on all sides that the internal-combustion engine is to be the universal prime mover of the future. Yet, while we are compelled to recognize the winning advantage of high thermal efficiency possessed by this type of motor, we cannot but deprecate the unfortunate fact that the general adoption of this type seems to mean inevitably a return to the slow-speed, cumbrous, costly, heavy-fly-wheel type of reciprocating engine, thus sacrificing the tremendous expenditure of energy and capital which has been, and is now being, made to bring the new rotary types of prime mover into the market, just at the time when all mechanical difficulties are being overcome and practicable machines of this type are being evolved, representing such a gratifying mechanical advance over the older unwieldy forms, the final passing of which, it has been hoped, we are about to witness.

It may well be marvelled at that such an extraordinary and most unscientific state of affairs can exist in this age of enlightenment as to things mechanical, yet it is the logical result and a striking illustration of the independent development of single ideas which has characterized the trend of invention and improvement in this most important branch of scientific achievement. In the development of the steam turbine, the one idea has been to obviate the notorious short-comings of the reciprocating engine as a machine, with the result that a type has been evolved which, while representing the last degree of refinement in mechanical design and operation, yet shares with the older type its complete dependence upon that most primitive and inefficient method of heat conversion, the steam-boiler system. On the other

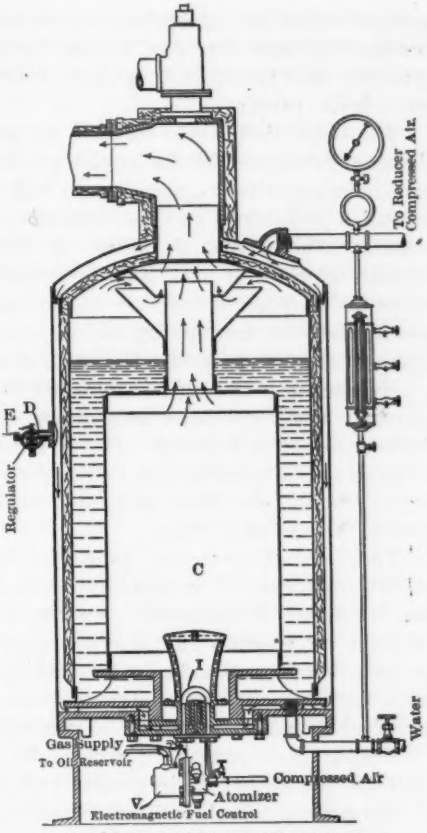
hand, we find the gas or oil engine developed in accordance with the single idea of thermal efficiency, and dependent for its very cycle upon the inherent characteristics of the reciprocating engine, the basic design of which is generally conceded to be wholly and hopelessly unsuited to meet the growing demands of modern power application. And now we find these two widely different systems or methods of doing the same thing in active competition, though it seems to be the general impression in engineering circles that if one system is to be perpetuated, the other must of necessity be abandoned.

In one notable instance, a single representative manufacturing concern is at present engaged in marketing no less than three distinct types of electric generating unit in equal powers. The commercial argument that the special conditions of each installation determine whether the standard Corliss-engine type, the steam turbo-generator, or the multiple-cylinder gas-engine outfit is required for best results, can hardly be accepted as warranting the existence of a multiplicity of radically different systems of power development. The fact is that all of the present available systems are about equally deficient as compared with a standard of absolute excellence, each type of equipment excelling in certain particulars and presenting corresponding offsetting deficiencies; and while under such circumstances it is natural that any given set of conditions might be more nearly met by one type than by another, this fact cannot be accepted as an argument in favor of a number of imperfect systems as against a single system embodying all the virtues and only such defects as may be common to all existing types of equipment. It is toward the realization of such a universal system as this that our efforts should be directed, since only in this way can maximum economy and availability in manufacture and application be attained. It is with this ideal in view that the following suggestion is made as to a means of consolidating the known merits of the various existing systems into one rational universally applicable system of power development, thus making possible the high thermal efficiency of the internal-combustion engine in connection with the mechanically ideal rotary types of prime mover.

The general object of the apparatus shown is to create from liquid fuel a constant gaseous pressure suitable for the operation of a steam engine of the rotary type, and in doing this, to eliminate to the greatest possible extent the characteristic and unavoidable losses of both the steam boiler and the ordinary gas or oil engine.

In the sectional drawings is shown the proposed construction of such an apparatus.

Kerosene oil is used for fuel, being injected into the combustion chamber and atomized by means of a compressed-air supply maintained by a continuously operating pump at a pressure about 20 pounds above the proposed working pressure of the apparatus. The oil is injected under the surplus pressure of 20 pounds through the magnetically actuated control valve shown, and is atomized by the action of the air jets on its way to the combustion chamber C, ignition being accomplished by the internally-fired porcelain tube, I.



PRESSURE GENERATOR DESIGNED BY MR. E. C. WARREN.

As shown, the combustion chamber is surrounded by a water chamber, with which it is in free communication *via* the baffle-plate arrangement at the top. As heat is evolved by the combustion of the fuel in the interior chamber, a portion is radiated through the dividing wall into the water chamber and steam is formed, just as in a steam boiler, the essential difference being that the gases of combustion are confined within the boiler shell, allowed to mingle with the steam formed, and the mixture supplied to the engine as the motive fluid. It seems probable that the mixture so formed may contain about 25 per cent. of steam, highly superheated by contact with the gases of combustion, the gases, at the same time, being reduced to a temperature suitable for use in an engine of the type contemplated. This arrangement relieves the walls of the combustion chamber from all

pressure strains and establishes ordinary steam-boiler conditions in the surrounding water chamber, so that the question of control of temperatures and pressures is brought within the limits of every-day steam-boiler practice.

The outer shell serves to form an air jacket around the water chamber, through which the surplus air from the air system is passed *via* a reducing valve, to gather up any heat radiating through the boiler insulation and return it to the combustion chamber to facilitate combustion. This heated air passes up around the burning mixture through the circle of small holes surrounding the atomizing tube, and forms an envelope of pure air which separates the combustible elements from the surrounding burnt gases, preventing objectionable diffusion and aiding in the attaining of perfect combustion.

In order to insure a perfectly combustible mixture it is of course necessary that the relative proportions of oil and air be accurately determined and maintained. This is accomplished by initially regulating or adjusting the air jets to give the proper flow of air relative to the oil supply, the latter being at a fixed rate, determined by the area of the discharge orifice.

The atomized mixture so obtained may or may not be in chemically perfect proportion for complete combustion. The velocity of efflux of the issuing jet of combustible is under control by means of the air valves in the atomizer and, if necessary, mechanical diffusion within the cone may be used to insure localization of combustion. With constant feed and velocity conditions, however, the envelope of pure heated air should insure the desired localization and perfect combustion.

Regulation of pressure is secured by wholly interrupting, intermittently, the flow of oil, by means of the magnetically actuated valve V, the pressure diaphragm D operating to interrupt the electrical circuit E on a rise of the working pressure, thus allowing a spring to close the oil valve; conversely, upon a fall of pressure, the circuit will be closed and the valve magnetically opened. This arrangement insures against any variation in the composition of the mixture, which might produce imperfect combustion, and only sufficient oil is admitted to maintain the working pressure and to meet the requirements of the engine load. This feature takes care of the question of feed variation, which, with any conceivable arrangement for throttling or graduating the supply, presents one of the most serious practical difficulties to be encountered in this class of apparatus. As a safety feature, provision is made whereby, in case of breakage or burning out of the ignition tube, the control circuit is broken, the oil valve closed, and the igniter flame extinguished.

The water level in the steam compartment may be maintained automatically in the case of small machines by means of the compressed-air system, or, in large powers, water may be injected after the usual manner of feeding steam boilers.

It would seem feasible to operate the apparatus with high economy at any desired pressure, since combustion will be equally perfect under all conditions of pressure or load.

As to the net thermal efficiency attainable, it is suggested that since all losses of the apparatus are reduced to merely a negligible amount of radiation, an economy considerably better than that credited to the best oil or gas engines may be reached by working the generator in connection with a turbine or rotary engine of high mechanical efficiency. In fact, it would appear that, with an engine having a mechanical efficiency of 90 per cent., and charging off 35 per cent. for exhaust, radiation, and leakage losses in the engine, and 10 per cent. for radiation and incidental losses in the "pressure generator," a net efficiency of heat conversion of something like 45 per cent. may be realized, and this in a combination giving the compactness, safety, and automatic features of the oil engine, together with the perfect mechanical operation and general reliability of the steam engine.

It is suggested that such an outfit fulfills in an unusual degree the requirements of power development in isolated plants, being self-contained and more compact than the slower-speed oil engine, yet there seems no reason to anticipate any limitation as to capacity when large powers are contemplated. An automatic equipment of this sort would also appear to be peculiarly adapted to solve the power problem in certain special fields for which there seems to be at present no suitable motive power—as, for instance, in traction service, the independently operated street car, the automobile business wagon, and the baggage-car electric lighting system for railway trains. The very material reduction of weight in marine-propulsion equipment would be obviously of great advantage in increasing the speed of steamships, while the improved economy of fuel may greatly extend the steaming radius and carrying capacity of vessels. In fact, it would seem that such a system—universally applicable and promising such gratifying economy in fuel, first cost, weight, bulk, and attendance—is most urgently required to keep pace with the rapidly growing demands of modern scientific and manufacturing progress, and must sooner or later prove the means of elevating the backward science of energy conversion to a plane commensurate with its tremendous importance as a factor in the development of the earth's natural resources.

THE PENALTY CLAUSE IN ENGINEERING CONTRACTS.

By W. Valentine Ball.

The ruling of the courts in the matter of penalty in engineering contracts is based on the common law which is the common heritage of English and American jurisprudence. Mr. Ball's examples therefore are properly drawn from cases on both sides of the Atlantic and have international interest and application.—THE EDITORS.

NEARLY every contract which is entered into for the construction of machinery, the building of a ship, or other similar works, contains a clause specifying the time within which the work is to be completed. As the damages which may result from the non-observance of this clause are difficult to estimate, the written document usually provides a penalty which is to be paid by the contractor or manufacturer if he fails to carry out his obligation; but inasmuch as hardship may result from a very strict enforcement of the time limit, the time lost owing to any cause which is or may reasonably be in the contemplation of the parties when the contract is signed, is usually excluded, and no penalty is exacted in respect of time so lost.

It is obvious, however, that there are many causes of delay in the execution of a contract which cannot possibly be foreseen or allowed for by the employer or the contractor at the date of the agreement. Extra work may have to be undertaken either at the request of the employer, or on account of some delay or difficulty which could not possibly have been taken into account by the manufacturer when the tender was made. In these circumstances it is obvious that some system has to be adopted by which the question whether the contractor is to be held liable for delay can be decided. All questions could, of course, be settled by proceedings at law or by arbitration, but the vicissitudes of business require that minor questions which continually arise shall be decided with the minimum of delay and expense.

It thus comes about that the enforcement of what is known as the penalty clause is left to the engineer. His position, which will be further dealt with later on, is practically that of an arbitrator between the person who employs him, whom it will be convenient to refer to as "the employer," and the manufacturer or contractor who has undertaken the work in question. It frequently rests with him

to say whether and under what conditions an extension of time for the completion of the work is to be allowed. In the exercise of his discretion he has only one duty, which is to act fairly and honestly; and so long as he does this, he is under no liability to anyone in so far as he is acting in a *quasi*-judicial position or as arbitrator.

In treating of the penalty clause and the interpretation which has been put upon it by the courts, it is necessary to refer to several cases which relate, not to engineers and contractors, but to architects and builders. For our present purpose, however, it is sufficient to say that the law which applies to architects, applies with equal force to engineers, and the principles upon which the penalty clause in a building contract has been interpreted, can be adopted in the case of a contract for the erection of machinery, for the building of a ship, or for the construction of a harbour or other works.

Before dealing with the question of extending the time it may be well to consider one or two cases in which penalties have been held to be recoverable. Thus, in some circumstances, penalties may be exacted although the delay is caused by alterations required by the employer. In the case of *Jones v. St. John's College, Oxford* (L. R. 6 Q. B. 115), it was agreed by a building contract that the plaintiff should before a certain date completely finish, according to certain specifications, a farmhouse and buildings, but subject to extras, alterations, or additions which might be made as mentioned in the agreement; and that the time mentioned in the agreements should be of the essence of the contract, so that if the work was not done by the day named, penalties might be deducted by the defendants from the amount owing from them to the plaintiff. Alterations were ordered, and the plaintiff failed to carry out the works within the time specified. The defendants having accordingly deducted penalties, the plaintiffs brought an action to recover on their contract. It was decided that they had undertaken to execute, not only the works specified, but also all alterations within the time prescribed in the contract, and that it was no implied condition of the contract that the alterations should be such as could reasonably be completed within this time. Where, however, in the case of alterations being ordered, the engineer has power to extend the time, but has not exercised it, and there is delay, the builder or manufacturer must not be mulcted in penalties.

In the case of *Westwood v. The Secretary of State for India*, ((1863) 7 L. T. 736), the plaintiff contracted to build a ship. The time of completion was fixed. The contract provided that alterations might be ordered, and that the engineer was to have power to allow

an extension of time for them. Failure to complete within the fixed or extended time was to subject the plaintiff to certain penalties. The engineer ordered various alterations, but the time for completion was not extended, with the result that the shipbuilder exceeded the time specified in the contract. In an action brought by the shipbuilder for the cost of the alterations, the Secretary of State entered a counterclaim for penalties. By way of answer to the counterclaim it was pleaded that the alterations ordered had made it impossible to complete the work within the specified time. The court held that this afforded a good answer to the claim for penalties.

It is a general principle which is consonant with justice that where delay is caused by the intervention of the employer, a waiver of the penalty clauses will be implied. Thus when the employer (as must often happen) during the progress of the work directs alterations to be carried out within a reasonable time, and these alterations are so mixed up with the work contracted for that it is impossible to separate them, a waiver of the penalty clause may take place.

In the case of *Thornhill v. Neats,* (8 C. B. N. S. 831) the plaintiff agreed to build six houses by a certain day and was placed under penalty if they were not completed. Before the date fixed for completion, it was agreed that the plaintiff should perform other work in and upon the houses, this additional work to be done within a reasonable time. In an action brought by the builder for work and labour done, the building owner set up, in answer, a claim for penalties for non-completion within the time specified. It was held however that there was a good legal answer to the claim for penalties on the ground that the defendant had in effect waived the penalty clause by agreeing that the entire work should be done within a reasonable time.

Again in *Russell v. Sa Da Bandeira* (13 C. B. N. S. 149) a clause respecting penalties, in a contract for the building of a ship, imposed a penalty of £5 a day on the shipbuilder for every day after a certain day if the ship should not be then delivered. The ship was not delivered until long after the day appointed, but a large portion of the delay arose from the interference of the building owner or his agent. It was decided that no sum in the nature of a penalty was recoverable by the employer.

Similarly, if the time of commencing the work is delayed, through no fault of the contractor, he will not be liable to pay penalties. Thus in the case of *Holme v. Guppy* ((1838) 3 M. & W. 387) the plaintiffs contracted to do for £1,700 the carpenters' work in a brewery which was being built for the defendants. The work was to be completed

within four and a half months from the date of the contract, and in default of completing within the said four and a half months the plaintiffs were to forfeit £40 per week for each week during which the carpenters' work was delayed beyond the 31st day of August, 1863—the expiration of the four and a half months. The defendants did not give the plaintiffs possession till four weeks after the contract was made. The plaintiffs did not complete till five weeks after 31st August. The defendants claimed to set off five penalties of £40 against the last instalment of the contract price. It was decided by the court that they could not do so; that the undertaking to complete was put an end to by the defendants' default in not giving the plaintiffs possession at the proper time; and that there was no evidence of a new contract to complete at any other time than the 31st August.

In an American case *(Mansfield v. New York Central, etc., Ry. Company* (1886), 102 N. Y. 205), certain contractors agreed to erect an elevated railway on a foundation to be prepared by the employers. It was held that the proper preparation of the foundations was an indispensable condition precedent to performance, and if the employers made default the contractor was not only dispensed from exact performance but had the right either to rescind, or if he elected to continue the work, to recover damages for the expense to which he had been put by the delay and default of the employer.

Subject to what has been stated above, the contractor or manufacturer is liable to pay penalties for delay, even when that delay is occasioned by matters over which he has no control. Thus it was decided in the case of *Budgett v. Binnington & Co.,* ((1890) 25 Q. B. D. 320), that prevention due to causes other than the employer's intervention, such as a strike of workmen, is not an excuse for failure to complete within the proper time. This principle, and the frequency with which strikes have in the past prevented the due fulfilment of important engineering contracts, has given rise to the insertion of a strike clause in every contract of importance. It should be observed, however, that where there is such a clause, the strike may, nevertheless be of so prolonged continuance as so to alter the conditions of the contract and the arrangements of the parties to it as to amount to a determination of the contract.

As has been already stated, the points which arise from time to time during the progress of the work are frequently left to the decision of the engineer, and his opinion is binding upon either party. This principle is illustrated by several cases. Thus in an action on a builder's contract, which provided that all the works should be left

complete and clear, to the satisfaction of the architect, and did not contain any provision for payment by instalments, it was decided (1) That the completion of the works to the satisfaction of the architect was a condition precedent to the builder's right to recover on the footing of the contract; (2) That he was not entitled to recover for the value of work done as to which, while incomplete, the architect had expressed approval so far as then partially executed, but which was not subsequently completed to the architect's satisfaction (*Richardson v. Mahon* 4 L. R., Ir. 486).

The necessary power and authority must, however, be conferred upon the engineer by the clearest possible language, for in agreeing to be bound by the decision of some one who is retained and paid by the employer, a contractor in one sense hands himself over to the enemy.

In the case of *Lawson v. Wallasey Local Board,* (11 Q. B. D. 229), the plaintiff entered into a contract with the defendants to remove 10,000 cubic yards of the Mersey contiguous to Leacombe Ferry for £5,000, and to finish the work completely under the direction and to the satisfaction of the defendants' engineer by the 1st of October 1878, subject to such an extension of time as the engineer might think reasonable, in case a temporary staging then erected on the site of the work should not be removed within such a time as would enable the plaintiff to complete the work by the 1st of October 1878. The defendants were to make monthly payments on the certificate of the engineer to the amount of 80 per cent. of the value of the work done during each month, and the balance of the sum of £5,000 on the completion of the work. There was also a clause in the contract providing that if any difference should arise between the local board and the contractor concerning the work contracted for, or concerning anything in connection with the contract, such difference should be referred to the engineer, and his decision should be final and binding on the local board and the contractor. The work was completed on the 11th November 1879, and then a correspondence took place between the plaintiff and the engineer with reference to the plaintiff's claim against the defendant board. The engineer admitted that the plaintiff was entitled to compensation for the expense caused by delay in consequence of the non-removal of the staging, and agreed to allow £15.10.0. per day for thirty-eight days, but they could not agree upon the amount due to the plaintiff for extra work and other expenses. In June 1880, the engineer sent a certificate to the Works Committee of the defendant board, stating that the work was finished to his satis-

faction, and that £1,065.19.0. was due to the plaintiff, and the defendants sent a cheque to the value of £962.6.2., that being the balance of the sum certified after making certain deductions. The plaintiff, after giving credit for this sum, brought an action against the defendants for £2,489.13.11. It was decided that it was not a difference concerning a matter in connection with the contract, and as to which the decision of the engineer was conclusive. In order to bind a contractor to the certificate or decision of an architect or engineer appointed by the party for whom the work is done, there must be very conclusive language in the contract. It was decided, also, that the documents set out in the case did not amount to a contract by the engineer, or a reference to or award by him as to the plaintiff's claims.

While it is possible for the manufacturer or contractor to become bound by the decision of the engineer, it is not so easy for the employers to arrogate to themselves the right of practically deciding whether penalties shall be paid or no. This proposition may be well illustrated by reference to another building case, namely that of *Wells v. Army and Navy Co-operative Society* (86 L. T. 764). There it appeared that by a clause in a building contract the contractors were to complete the whole of the works within a certain time unless they were delayed by specified matters "or other causes beyond the contractors' control, satisfactory proof of all which must at the time of occurrence be at once afforded to the board of directors of the employers, who shall adjudicate thereon and make due allowance therefor if necessary, and their decision shall be final." It was decided that the exclusive jurisdiction of the directors under clause 16 did not extend to delay caused by undue interference by the building owners or their architect with the conduct of the works and by default in not giving possession of premises on which work was to be done, and in not providing plans and drawings in due time, and that the plaintiffs were, therefore, relieved from their liability for penalties under the contract for delay.

The power of granting an extension of time, which, as we have seen, is frequently conferred upon the engineer, must be exercised by him in strict accordance with the terms of the contract between the parties. This was emphasised in the very recent case of the *British Thomson Houston Co. (Ltd.) v. West Brothers,* (1903) (19 T. L. R. 493). There an action was brought by building owners to recover penalties for non-completion on the date agreed under the contract between the parties. This document provided that the architect might, in certain circumstances, extend the time for the completion of the

work, but did not expressly confer upon him the power to deal with penalties. There was admittedly a delay in the execution of the works, but the defendants contended that the delay was impliedly permitted by the architect, who had given his final certificate in the following form:—"We hereby certify the sum of £536.15.5 is due to Messrs. West Brothers in settlement of contract for the erection of power stations." The question of law for the opinion of the Court was whether, in view of the certificate, and of the powers of the architect under the contract, this certificate afforded a complete answer to the plaintiff's claim. Mr. Justice Phillimore, in giving judgment, said that the following, which is taken from *Hudson on Building Contracts,* was an accurate statement of the law:—"If the architect gives a final certificate without allowing any deduction for penalties, it will be presumed that he has extended the time for completion, unless, as in the foregoing illustration, it is proved or admitted that the matter has not been determined by him, or was not expressly or impliedly within his jurisdiction." His lordship went on to say that the architect's certificate at most raised a very strong presumption that in giving his certificate he had taken all the circumstances of the case into consideration. That presumption, however, might be rebutted, and in all the circumstances he would have to enter judgment for the defendants.

Hitherto we have dealt entirely with the penalty clause; there is another clause of a similar nature which is often inserted in these contracts, the administration of which depends very largely upon the engineer.

We refer to the "bonus" clause. A contract sometimes contains a clause providing that a bonus shall be paid to the contractor for expedition. If there is such a clause, and the engineer has power to extent the time, this power, according to a New Zealand case, is not to be exercised by the engineer for the purpose of enabling the contractor to earn the bonus, but, on the contrary, to save him from the penalties. In the case in question *(Ware v. Lyttelton Harbour Board* (1882) 1 New Zealand L. R., S. C. 191), it was agreed by a contract that "The Board will grant the contractors a bonus of £100 per week for every week or part of a week in which the contract shall be finished within the specified time." The contract was to complete certain specified works and additional or extra works if properly ordered. The date for completion was the 7th April, 1882. The plaintiffs completed six weeks before the appointed day and received £600 bonus. They claimed further bonus for time taken as they alleged by extra works. The engineer had power to extend the time. It was decided

that the clause only applied in case the engineer should consider that the contractors could not complete within the time, to save the contractors from penalties, and not to give them additional bonuses.

If the employer agrees to give a bonus for expedition, and the contractor to pay a penalty for delay, and the covenants are independent, and the covenant to pay a penalty for delay is absolute, if the contractor has been prevented by the employer from completing by the date fixed, he must pay or allow further penalty; but he has an action for damages against the employer, including the deductions caused by the employer's neglect.

"Any other construction," said Baron Alderson in *Macintosh v. Midland Counties Railway Company*, ((1845) 14 M. & W. 548), "would lead to this conclusion, which we think an unreasonable one, that the non-supply of a single rail or chair (by the Company) at the time specified for its delivery, although in the result wholly immaterial to the facilities for completion, would entitle the plaintiff to receive the £15,000 given as expedition money, without his giving expedition for it."

The question has frequently arisen whether in acting in his professional capacity an engineer can be sued for negligence either by the building owner or by the builder whose work he has to criticise. It is not necessary for our present purposes to go at length into the question; it is sufficient to point out that so far as he acts as an arbitrator the architect cannot be held responsible.

In *Restell v. Nye* (17 T. L. R. 304), the facts were that by a building contract the certificate of the architect, employed by the building owner, showing the final balance due or payable to the contractor, was to be conclusive evidence of the works having been duly completed, and that the contractor was entitled to receive payment of the final balance. It was decided in the Court of Appeal, that the architect, in giving his final certificate, was placed in the position of an arbitrator as between the building owner and the contractor, and was not liable for negligence. An engineer would be in a similar position.

MECHANICAL AND COMMERCIAL ASPECTS OF THE ALCOHOL MOTOR.

By Henri Dupays.

Local conditions make the alcohol motor perhaps more immediately important on the Continent than elsewhere, but every extension of the supply of industrial fuel is significant. Alcohol has, further, qualities which recommend it strongly for use in internal-combustion motors applied to the driving of automobiles, and it is in this relation that M. Dupays discusses it most fully. His intimate connection with the most notable experimental researches which have been made in this direction give him especial standing as an authority.—THE EDITORS.

ALCOHOL can be obtained from all substances containing sugar, or containing compounds which may be transformed into sugar. The sources of supply are therefore very numerous and large quantities are annually thrown upon the market. Equally numerous are the industrial uses to which it may be put, and during very recent years alcohol has taken an important place, especially among the available agents for the generation of motive power, of light, and of heat. This mode of utilisation of alcohol, however, is susceptible of much larger development, and that fact makes it important to review its adaptability to purposes of power generation and the bearing of its characteristic properties thereon.

Not until recently has alcohol for motor purposes been exploited to any great extent, other than as a substitute for water in the boiler, or as an admixture to the usual heat medium. The years 1894 and 1895 saw the first attempts, in Germany, to employ alcohol in internal-combustion engines, in place of the distillation products of petroleum. These attempts, it may be added, were not successful. In 1897, however, Max Ringelmann showed in a series of experiments conducted by him at the Experimental Mechanical Laboratory (*Station d'Essais de Machines*) at Paris, that with certain precautions, such a substitution was feasible. Since then, in 1899 and 1900, the new fuel has come into prominence in several automobile road races.

The results of these various investigations were not accepted without hesitation, however, and gave rise to much acrimonious discussion. At the same time the idea was slowly gaining ground, so that, when the unprecedented vintages of 1900 and 1901 threw an alcohol on the

ALCOHOL AUTOMOBILES ON THE NORTHERN CIRCUIT TRIALS, 1902.
Taken during the stop in a neutral control.

market which could compete in price with that made from beets and from molasses in the north, and, by the depression of the value of wine, forced all large owners of the south to do their utmost to create a market for this product, it was not long before the subject was granted serious attention. In November 1901, and later, in May 1902, the Department of Agriculture (of France) offered special prizes for researches tending to widen the field of utility of alcohol. Under the influence of careful supervision and of scientific methods, these researches have borne many valuable results. In the succeeding pages I shall particularise briefly on some of the facts thus discovered, basing the observations upon the experiments of Max Ringelmann at the Experimental Mechanical Laboratory of Paris, experiments in which it has been the good fortune of the author to take part.

Two kinds of alcohol are applicable to motor use:

1.—Denaturalised alcohol, which consists of pure ethyl alcohol to which is added, in France, per hectolitre, 10 liters methyl alcohol, containing 20 per cent. acetone, and 0.50 grams heavy benzine.

The main object of this denaturalizer is to protect the excise revenue against frauds; it serves its purpose rather indifferently, however, being not only quite expensive (francs 10.90 per hectolitre) but also quite unreliable, as it may easily be removed. It also diminishes the calorific power.

2.—Carburetted alcohol, which is denaturalised alcohol to which a hydrocarbon has been added in varying proportions, the substance most generally used being benzine. The object is to increase the calorific power of the fuel. A 50 per cent. mixture seems to give the best results.

The chemical composition, of course, is by no means constant, each class being simply a mechanical mixture. Sorel has determined the following values for pure denaturalised alcohol, and for a 50 per cent. carburetted alcohol, using a kilogramme for the determination:—

	Carbon.	Hydrogen.	Oxygen.	Water.
Denaturalised Alcohol.....	0.437	0.111	0.303	0.141
Carburetted Alcohol.....	0.690	0.095	0.147	0.068

An objection frequently raised to all alcohol for fuel purposes is its low calorific power. The following table, which gives the value of this constant for the different liquids at present used in internal-combustion motors as determined on Mahler's calorimeter, will show that this claim is not unfounded:—

Substance.	Calorific Power.
Denaturalised Alcohol.....	5,906 calories per kg. (10,631 BTU per lb.)
50 Per Cent. Carburetted Alcohol	7,878 " " " (14,180 " " ")
Light Petroleum Essence (Mean)	10,500 " " " (18,900 " " ")
American Crude Oil.....	10,913 " " " (19,643 " " ")
American Refined Petroleum...	11,047 " " " (19,884 " " ")

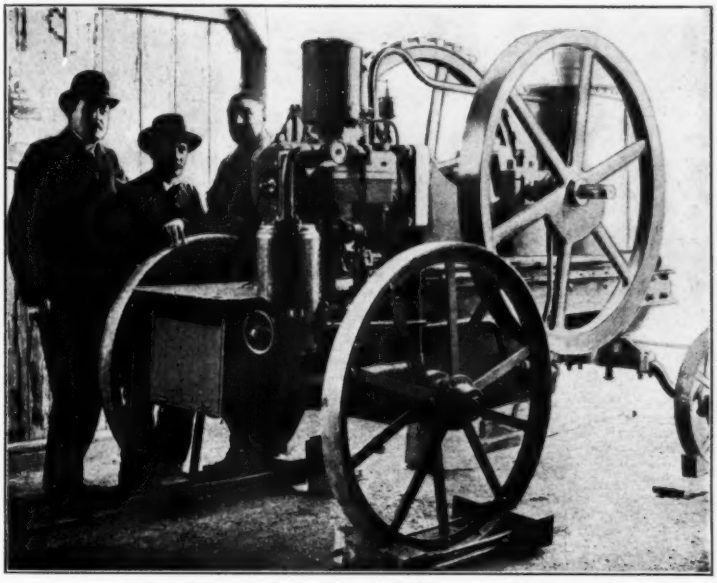
These figures certainly do not look favourable for alcohol.

On the other hand, we must remember that owing to the lower heat generated by the combustion of alcohol, a motor using that fuel will run more smoothly than if one of the other substances had been employed. Further, a kilogramme of alcohol requires less air for complete combustion than does a kilogramme of mineral oil (according to Ringelmann (1894) 1.4, and according to Sorel 1.3 to 1.5 the theoretical amount). This decreases the heat losses in the exhaust gases very materially, and gives a higher thermal efficiency.

One of the advantages of the alcohol motor is that, when properly regulated, the escaping gases do not have the disagreeable odour which is so objectionable with gasoline machines. In fact, except for a short time after starting the machine, when a little formic aldehyde is given off, there is practically no smell of any kind.

Starting a motor which burns carburetted alcohol is no more difficult than starting one that derives its energy from the lighter derivatives of petroleum, and is done in the same way in both cases. Denaturalised alcohol, on the other hand, will not vaporise sufficiently

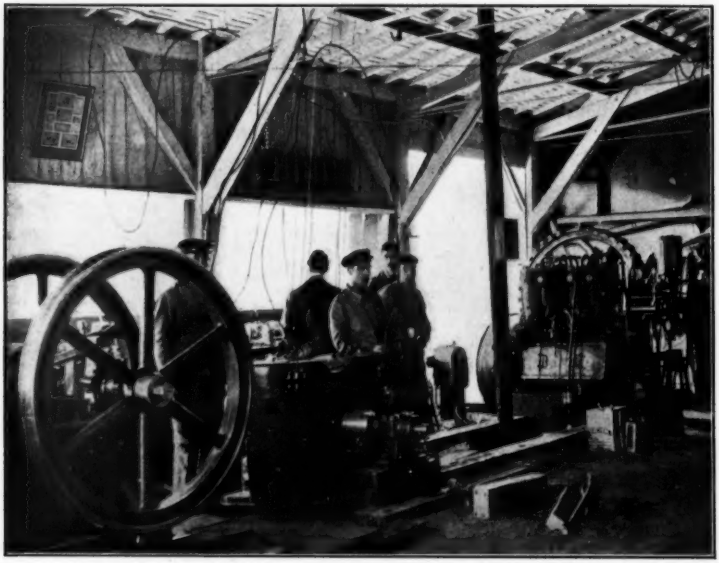
for good service at temperatures below 20 deg. C., so that it will be necessary either first to heat up the carburetter slightly by burning a little of the liquid under it, or to let gasoline or a similar substance take the place of the alcohol during the first few explosions. After a very short time the heat of the exhaust gases, if properly utilised, will be sufficient to keep the carburetter at the required temperature, and to neutralise the cooling due to evaporation.



AN ALCOHOL-MOTOR PORTABLE ENGINE.

Alcohol does not, as too often alleged, foul the admission valves and the sparker. Cases are known, it is true, where a slight deposit of lamp-black and even of tar has been formed; but as such occurrences are very rare, we should not blame them to the fuel used, but rather to a bad carburetter.

The water of condensation from the exhaust always contains a little acetic acid, the proportion being very variable. The amount is rarely sufficient to attack the valves, however, and with a little care trouble from this source may always be avoided, for it is found that corrosion does not take place unless the motor is allowed to cool and the condensed water to remain in contact with the metal for some time. Greas-



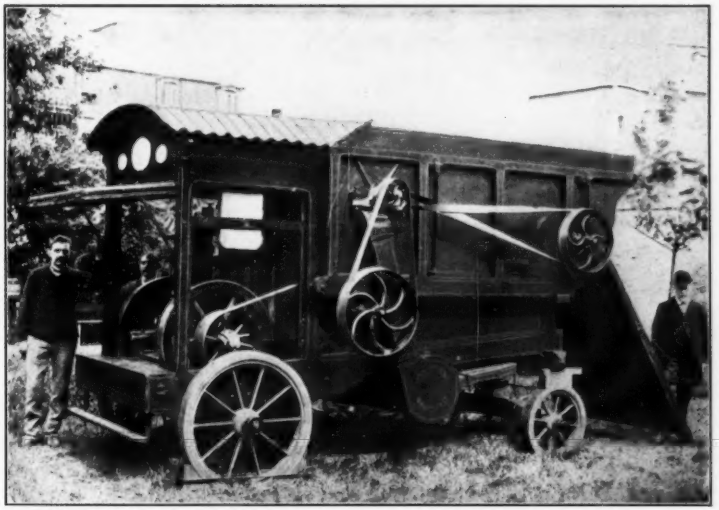
FOUR-CYLINDER 50-HORSE-POWER ALCOHOL MOTOR IN OPERATION.

ing the cylinder slightly when not in use will therefore be a perfect safeguard.

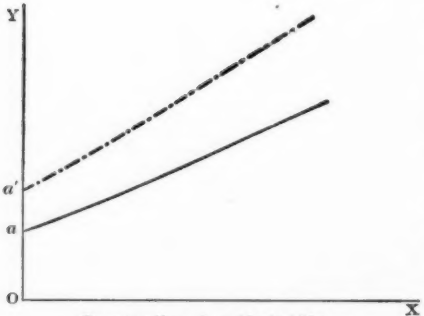
As with all internal-combustion motors, the most important member is the carburetter. Improper construction in this detail will always react very unfavourably on the performance. Unless the correct proportion between the air and the gas be maintained, the combustion will not be complete. This is especially true if not enough air is admitted, the result being a deplorable loss of efficiency. Some motors lose in this way 50 and even 80 per cent. of the available energy of the fuel. Aside from the loss in efficiency caused thereby, incomplete combustion is further objectionable in that it sets up secondary chemical reactions, aldehyde and acetic acid, methane and its derivatives, acetylene, benzine, and even formol and hydrogen being produced in some cases. On this point the chemical researches of Sorel at a laboratory set aside for this purpose at the *Station d'Essais de Machines* have led to some very interesting conclusions; conclusions, it may be mentioned, which are fully borne out by the results of purely mechanical investigations. Referring in particular to a very common method of charging the air with vapour, Sorel says that "it is very bad practice to pass more or less highly heated air either over or through a liquid consisting of several

substances in a state of purely mechanical mixture, the surface of the liquid being held at a constant level by means of a float, so as always to be in excess. The direct and unavoidable result of this process will always be constant change in the composition of the liquid, and under such conditions no motor can act satisfactorily." A similar line of reasoning applies to carburetters where "the air is charged with inflammable gases by being brought in contact with wicks dipping into the liquid mixture to be utilised." The best carburetter from a mechanical point of view will be the one which introduces automatically into each cylinder that quantity of alcohol—which may be constant or variable, depending on the system of governing employed—which is strictly necessary to do the work, and in which the temperature is such as to insure rapid and complete evaporation of this charge in the least volume of air required to produce complete combustion. Carburetters fulfilling these conditions for alcohol exist. Constructed originally to be used in connection with shale oil, they have acted perfectly when alcohol, either pure or carburetted, was substituted. It might be difficult to show that the vaporisers now used with light mineral oils give equal satisfaction.

Max Ringelmann is responsible for the very elegant method of expressing the fuel consumption of an internal-combustion motor which



THRESHING MACHINE OPERATED BY AN ALCOHOL MOTOR, AT THE MECHANICAL TESTING LABORATORIES.



Consumption of an Alcohol Motor
——— 50 per cent carburetted alcohol
·—·—· Pure denaturalized alcohol
X. Brake horse-power
Y. Consumption in kilogrammes per hour

we give below. The hourly consumption y is a linear function of the power developed, x, and is expressed by the formula

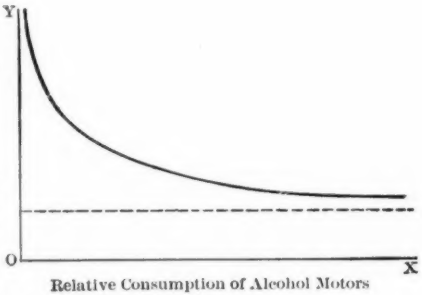
$$y=a+bx.$$

This is the equation of a straight line whose intercept on the axis of y, a, is the consumption when the machine is running under no load. The value of a will depend on the construction, the adjustment, the sparking mechanism, the method of governing employed, the heat losses, and on other similar details. The constant b is independent of the machine; it varies inversely as the calorific power of the fuel used. Thus b will be greater for denaturalised alcohol than for 50 per cent. carburetted alcohol, and greater in the ratio of 10 to 7. Again, the hourly consumption of a given motor when using pure denaturalised alcohol, and when using 50 per cent. carburetted alcohol, will be as 10 is to 7, that being the inverse ratio of the calorific powers of the two fuels.

The specific consumption Y, that is, the consumption per unit of power, is given by the formula

$$Y = \frac{y}{x} = \frac{a}{x} + b$$

which is the equation of an equilateral hyperbola with asymptotes $x=o$, $y=b$. The specific consumption therefore diminishes as the horse power increases. It is always less in stationary than in portable and automobile engines, the former having neither ventilating devices nor circulating pumps for water cooling. The following table shows the specific consumption of the best constructed motors entered in the international exhibit of 1902 as deduced from in-



Relative Consumption of Alcohol Motors
X. Brake horse-power
Y. Consumption per horse-power hour

vestigations carried on at the Experimental Mechanical Laboratories. The figures are in the metric system; their English equivalents are added in brackets.

EXPOSITION OF ALCOHOL MACHINES, 1902. MOTOR SECTION.
In the centre is the automobile track.

Motor.	Maximum Horse-Power x.	Consumption per H. P. Hour Y for 50 Per Cent. Carburetted Alcohol.
Low Speed Stationary Motors.		
Brouhot	1.83 (1.80)	0.551 kg. (1.231 lbs.)
Sté. de Winterthür	5.15 (5.08)	0.326 kg. (0.729 lbs.)
Pruvost	8.35 (8.24)	0.337 kg. (0.753 lbs.)
Brouhot	16.34 (16.12)	0.233 kg. (0.521 lbs.)
Sté. de Winterthür	34.37 (33.90)	0.293 kg. (0.655 lbs.)
Vehicle Motors.		
Beaupré	6.39 (6.30)	0.459 kg. (1.026 lbs.)
Brouhot	8.31 (8.20)	0.412 kg. (0.921 lbs.)
High Speed Motors.		
Sté. l'Aster	6.14 (6.05)	0.387 kg. (0.865 lbs.)
Panhard et Levassor	8.84 (8.72)	0.377 kg. (0.843 lbs.)

One of the large prospective consumers of alcohol will be the automobilist. In the northern circuit a machine burning carburetted alcohol attained a mean speed of 72 kilometres (44.7 miles) per hour on a

ALCOHOL MOTOR TRUCKS ON THE ROAD, PARC D'ACHÈRES, 1901.

Taking a sample of alcohol from the reservoir.

poor road and long run of 924 kilometres. A Panhard or Levassor motor using the same fuel made an average of 90 kilometres (55.9 miles) per hour on the first stage of the Paris-Vienna race. Such a high speed had never before been reached on the Paris-Belfort run. The adaptability of alcohol to this use cannot be doubted, therefore; to make it a commercial success, however, it would be necessary to establish bases of supply throughout France where the tourist could replenish the reservoirs of his car. Unfortunately it must be acknowledged that so far very little has been done in this direction.

The competitive exhibition of 1902 necessitated the installation at the Experimental Mechanical Laboratory of a dynamometer constructed specially for measuring the effective power at the wheel rim of automobiles. The principle of this device is very simple. The car is mounted on two leather belts running lengthwise over pulleys. The resistance of these belts is regulated by means of a brake, and the car is held in place by being attached in the rear to a fixed point through a self-registering dynamometer. Experiments on the fuel consumption made in this way were found to agree perfectly with those made during road tests. The table on the following page shows a few of the figures obtained, the English equivalent of the metric figures being given in each case, in the parenthesis.

	Mean Speed per Hour.	Hourly Consumption of 50 Per Cent. Carburetted Alcohol.
On the Road.....	21.0 km. (13.0 m.)	1.20 kg. (2.64 lbs.)
	18.5 km. (11.5 m.)	1.40 kg. (3.09 lbs.)
	17.5 km. (10.9 m.)	1.44 kg. (3.18 lbs.)
On the Apparatus.....	13.0 km. (8.1 m.)	1.486 kg. (3.28 lbs.)

To the buyer of a racing machine the available effective power at the wheel rim is the main point of interest. For touring cars, however, and even more so for delivery wagons and trucks, and for all vehicles used for business purposes, the consumption becomes an important factor. Researches made on the latter class of wagons only demonstrate that the fuel consumption per tonne per kilometre decreases as the total transported load increases; as indeed theory would lead us to expect.

H. P. of the motor (English in brackets.)	Weights in kg. (in lb.) Of the empty car.	Of the useful load.	Mean velocity per hour in km. (in miles).	Consumption of 50 per cent. carb. alcohol in cu. cm. per tonne-km. (cu. in. per ton-mile). Of the total load.	Of the useful load.
4.5	910	1186	15	38.7	99.6
(4.44)	(2006)	(2615)	(9.3)	(4.18)	(10.76)
10.0	1396	1614	21.9	27.3	134.2
(9.86)	(3078)	(3559)	(13.6)	(2.95)	(14.49)

The consumption per tonne-kilometre of the useful load is influenced to a certain extent by the weight of the wagon, so that economy demands that this latter be made as small as possible without exceeding the limits of safety imposed by the strength of the materials of construction.

From the foregoing it will be evident that from a purely technical point of view alcohol is well fitted to take the place of petroleum and its derivatives for driving stationary, vehicle, and marine motors. Unfortunately, however, the commercial aspects of the situation are not nearly so encouraging. In spite of the liberal encouragement given by the government, and in spite of the rapid strides made in perfecting the mechanical appliances, the industrial development of alcohol as a fuel is at present nearly at a standstill. And this rather distressing condition of affairs is due entirely to those whose own interests should prompt them to foster the growth of the industry; for at the present price of the commodity, alcohol cannot compete successfully with its rivals.

The duties imposed by the State upon the manufacture of alcohol have frequently been changed; at the present date a rebate of 9 francs

per hectolitre is allowed on all alcohol which has undergone the process of denaturalisation, and the only taxes collected are one of 0.25 francs for registering the output and one of 0.80 francs for analysing. Under these conditions the cost of denaturalising a hectolitre of alcohol is francs 10.90 less the rebate (which for a hectolitre of denaturalised alcohol containing 81.5 litres of pure alcohol amounts to $\frac{9 \times 81.5}{100}$ = 7.3335 francs), that is to say,

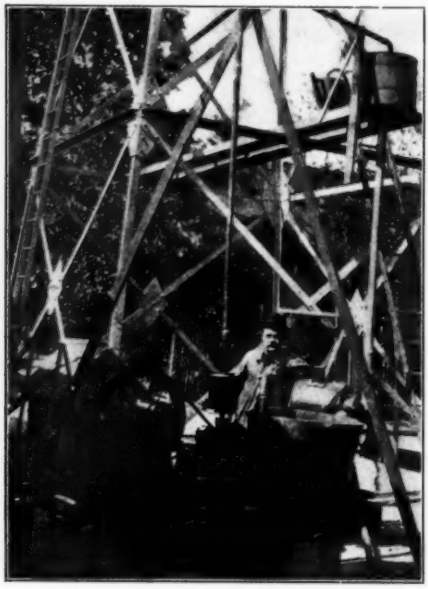
francs 10.90—francs 7.335=francs 3.565.

This added to francs 45.25, the market price of the alcohol, gives

francs 45.25+francs 3.565=francs 48.815

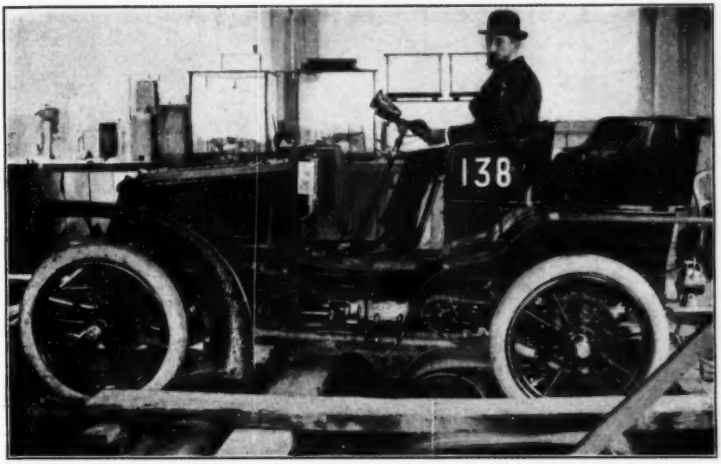
as the cost of one hectolitre of the denaturalised product.

Now this figure is entirely too high. Speculation, and speculation alone, is responsible for it. Under normal conditions it should be perfectly possible to sell this article for from 25 to 30 francs per hectolitre. Herein, as far as we can see, we must recognise the one stumbling block which has prevented alcohol in France from taking that position among the available fuels of today to which its characteristic properties would seem to entitle it. Manufacturers have thought it to their interest to keep up the prices; the consumer, however, is by no means willing to second them in this effort.



ALCOHOL MOTOR OPERATING A PUMP.

Germany is very frequently quoted to us as an example in this matter. Denaturalised alcohol can be bought there for franc 0.25 per litre delivered at any railroad station. Several causes contribute to make this low price possible. One of them is the unusually low cost of production in that country, alcohol being there manufactured largely from potatoes, which require but little labour in their cultivation and can



ALCOHOL MOTOR CARRIAGE UNDER TEST AT THE "STATION D'ESSAI DE MACHINES."

be successfully grown in ground which is otherwise of very slight value. Another reason lies in the very stringent legislation against adulteration. But the most important cause is found in the application of the principle of co-operation. The syndicate of agricultural distillers, which controls 80 per cent. of the output, sells its entire product through a single agency—the *Centrale für Spiritus Verwerthung* (Office for the Sale of Alcohol) established in 1899. The commercial organisation of this company is in many ways remarkable; it has succeeded in assuring to the manufacturer a satisfactory profit, and to the public a condition which in France is still a thing to be hoped for in the future, namely, a low price for alcohol.

THE TRANSMISSION LINE.

THE FIRST HYDRO-ELECTRIC STATION OF GREECE.

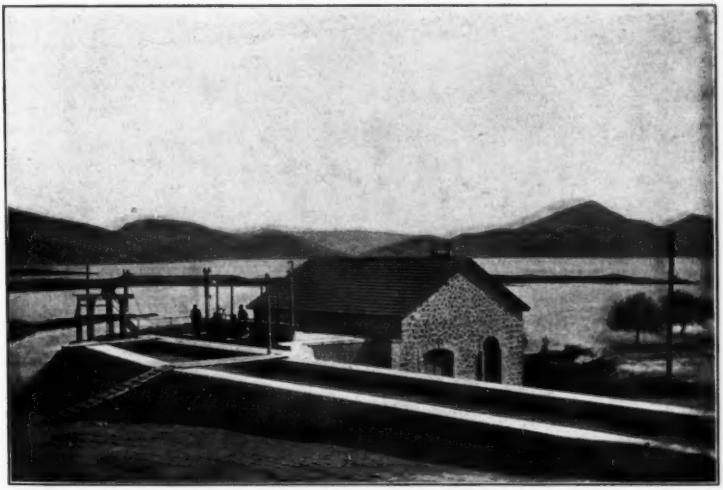
By Emile Guarini.

Apart from the interest suggested by M. Guarini, his article is highly suggestive of the keenness and promptness of Continental engineering manufacturers in finding new outlets for their products. In this aspect the short account may have some hints for the engineering trades nearer home.—THE EDITORS.

GREECE, it is well-known, is generally rocky, sterile, and poor in water resources. Pindar and the other poets of ancient Greece do indeed sing the praise of the beauty of the rivers of their land, but times have changed; Greece has been deforested, and her streams—the beauty and the noble flow of whose waters was probably at all times a little exaggerated by poetic inspiration—are now but torrents whose beds are completely dry during a good part of the year. It is therefore not a little surprising to hear of the installation of a hydro-electric plant in a country so deficient in water power—to think of dynamos humming at the foot of Mount Helicon, and triphase currents encircling Parnassus—to associate a modern electric-power station with the traditions of Lake Copaïs, once famed for its eel fisheries, or of the River Cephissus, especially loved by the poets.

Just there, however, at the foot of the mountain of the Muses, Ganz of Budapest has installed a 5000-volt triphase power station for the account of the English company which has undertaken the drainage of Lake Copaïs. It replaces a temporary installation of Gwynne pumps used for some years past for drawing off the waters of Lake Copaïs from those low lands which were sunken below the level of the drainage channels. The limited capacity of the pumps, however, and the enormous cost of fuel for operating them, suggested resort to the utilisation of the waters of the lake itself, by transforming the water power of a fall into electric energy. The idea was conceived by Mr. Steel, and has proved entirely practicable. The waters, for centuries idle, which Lake Copaïs receives from the northern and eastern flanks of Parnassus, from the north slope of Helicon, from the many little girdling hills which surround it, and from the River Cephissus and scores of winter torrents—these will now be put to the prosaic work of driving dynamos as they pass, by a tunnel, to Lake Likeri with a fall of 8 or 9 metres.

Near to this fall has been placed the power house, built of field stone cemented with pozzuolano and in parts with portland cement. It contains two Francis turbines, built by Ganz, for a fall of 7 or 8 metres. They are virtually duplex, and have a common discharge. The guaranteed efficiency is 80 per cent when the flow is full or not



VIEW OF THE POWER HOUSE AND HEAD RACE.

below three-quarters, and 75 per cent with a flow of half the normal volume. The regulation is effected from the power room by means of levers.

The turbines are direct-coupled to two Ganz triphase alternators of 130 kilowatts at 210 revolutions. The potential between each two phases is 5,000 volts. The poles of the field are of steel, with copper-band winding; the winding of the stator is star-connected and insulated with micanite tubing. The exciting current is furnished by a four-pole exciting dynamo placed on the extension of the main shaft.

THE POWER HOUSE, WASTE WEIR, AND TAIL RACE.

The current is led from the alternator to the distributing switchboard by conductors supported on porcelain insulators and carried through an underground conduit. The same precaution is observed in the receiving station. In both stations, also, all the iron parts of the distributing switchboard and of the machinery are carefully earthed. The switchboards themselves are provided, front and rear, with wooden platforms resting on large porcelain insulators. All the parts carrying high-tension current are consigned to the back of the switchboard. The circuit breakers are three-pole, rapid-break type; the fuses are contained in fibre tubes encased in massive ebonite.

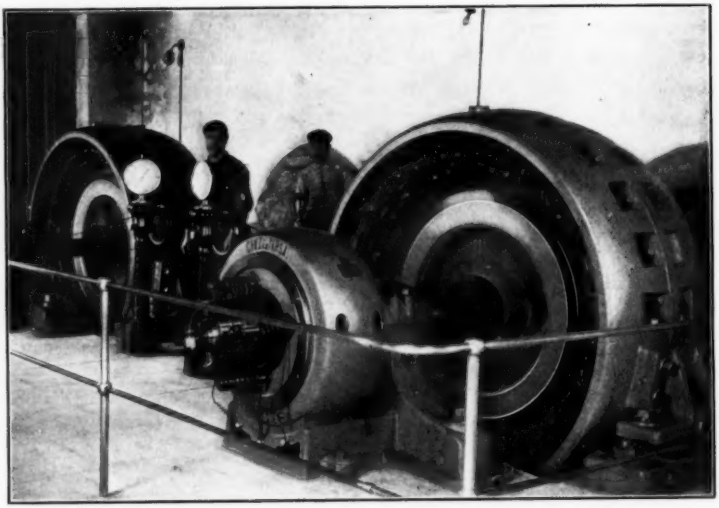
The current is taken from the central station to the pumping station by a line of three electrolytic-copper wires supported on creosoted poles—the outlines of which are enough to raise the hair of the

archaeologist (if he had any), and of the aesthete (who always has plenty). Be that as it may—the wires are 6 square millimetres in section and are carried on quintuple-petticoated insulators. Two of the insulators are placed on one side of the pole, and the third on the other side at mid-height between the two. Each pole is sunk 1.75 metres in the ground and rises 7.65 metres above it. At a distance of 1½ metres below the 5,000-volt line is placed the telephone line, well insulated and crossed every half-dozen poles. The effects of induction are entirely avoided.

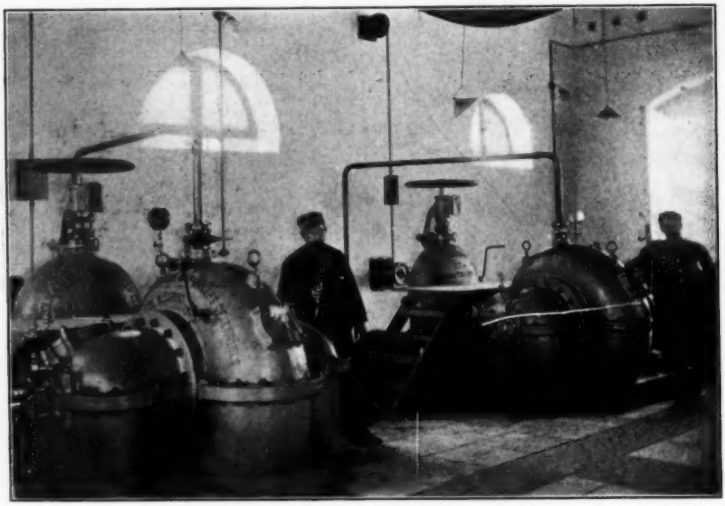
The end of the triphase line is equipped with lightning arresters of the horn type. Entry to the station is made by two poles, anchored to the wall, and large tubes of micanite. Although the distance between the two stations is 13 kilometres, the loss in the line is only 6.3 per cent.

THE DISCHARGE SIDE OF THE PUMPING STATION.

The pumping station proper is built of the same materials as the power house. It contains two triphase motors of 80 brake horse power each, running at 490 revolutions a minute: they are driven directly by the 5,000-volt current, without any preliminary transformation. Direct-coupled to them are the centrifugal pumps, raising 760 litres of water per second to a height of 4 metres. The control and operation are so simple that it is possible to employ as workmen those having no experience at all with electric machinery.

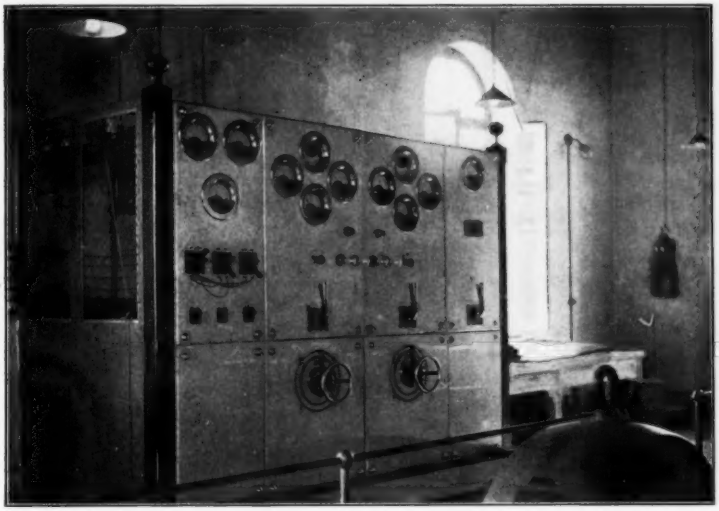


INTERIOR OF THE POWER HOUSE, SHOWING THE GENERATING MACHINERY.



INTERIOR OF THE PUMPING STATION.

The use of the electric power generated at the turbine station is not limited solely to the operation of the pumps, though that was the chief object of the installation. It serves also for certain agricultural uses, for the lighting of several offices, and for driving a number of small machines. It is thus completely utilised.



THE MAIN SWITCHBOARD.

Important results are expected from this plant, especially hygienic results to be secured by the removal of the stagnant water from the low grounds spoken of at the beginning of the article. Although an installation of this sort in one of the spots most celebrated in ancient history and fable may appear an anachronism—a just cause for grief to the Hellenist—it is nevertheless to be welcomed and its successful accomplishment regarded as a reason for felicitation, since it has a worthy humanitarian purpose and result. This is the promotion of public health by the removal of the stagnant waters and the mosquitos which bred in them. And further, it affords an example of the profitable turn which may be given to conditions apparently most unfavourable to the economical generations of electric power.

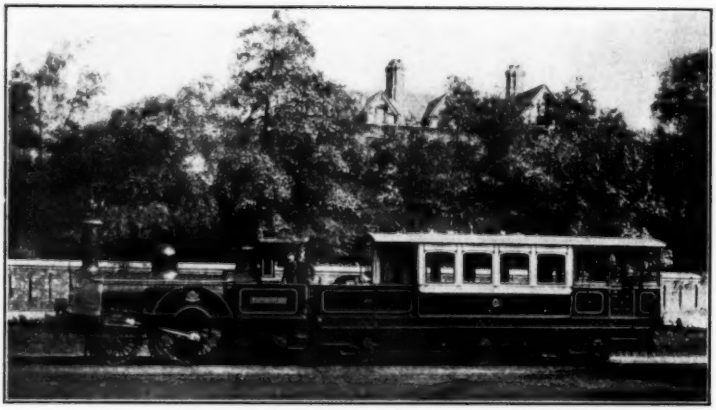


FIG. I. INSPECTION ENGINE AND SALOON, LONDON & NORTH WESTERN RAILWAY.

LOCOMOTIVES FOR SPECIAL SERVICE ON BRITISH RAILWAYS.

By J. F. Gairns.

IN a general sense, every locomotive owned by a railway company is a money-making machine; its success or non-success is judged by the load it can pull, its economy in working, its immunity from accident, the lightness of its repair bill, and its generally satisfactory character, all being considered from a dividend-earning point of view. This, however, does not strictly apply to every engine working in regular service, for on the British railways there are many engines, some of modern build and special design, others old engines fulfilling a useful purpose in their declining years, whose earning power is *nil*, and which do not directly add a penny to the receipts of the railway which owns them either by conveying booked passengers or paid-for goods. A few of these engines, together with some others designed and used for special service, will be described in this article.

Locomotives which are designed for regular service are not always suitable for the special and private duties which form part of the operations of every railway company, and accordingly, on many lines, locomotives are built, or converted, to meet these requirements. To

this class belong "inspection" engines, "crane" engines, and "works" engines, and these will first receive attention.

On all lines, periodical inspections of the whole system are made by the directors and head officials, and occasional trips are also made for special purposes, such as inspections by Board of Trade officials and the like. On these journeys it is not always convenient or possible to use the regular trains, and while many railways use for such duty any engine which is available, or employ a particular engine of ordinary design, to haul a directors' or official saloon wherever required, a few lines have provided special engines or combined engines and saloons for this work.

These inspection engines are in most instances old engines, too old for regular service but quite capable of doing inspection work, fitted or altered as required; but in other cases they are specially built for inspection purposes.

In Figure 1 I illustrate, by the courtesy of Mr. F. W. Webb, the late locomotive superintendent of the London and North Western Railway, the inspection engine belonging to Britain's "premier" railway. This interesting machine is actually an old "Trevithick" 6-feet single-driving engine, but instead of being broken up, as have all its *confreres*, it has been provided with a six-wheeled "coupé," the front portion of which forms a bunker for coal and water (these engines do not burn very much fuel or use much water, as the load is always light), while the rear is fitted up as an open observation platform, the middle portion forming a well fitted up saloon. The "Locomotion" as it is named, is usually driven by one of the most experienced drivers, who is familiar with the signals, running restrictions, and the conditions existing over the whole system, so that he can go anywhere and everywhere as required; and it is sufficiently speedy to be able to keep clear of even the fastest expresses on the line, while it can, if need be, haul another saloon when more accommodation is wanted than is provided by its own saloon. Usually this engine is reserved for the use of the locomotive chief. It was converted and prepared according to the designs of Mr. Webb.

On the North Eastern Railway there are two inspection engines, one for the service of Mr. Wilson Worsdell, the locomotive superintendent, to whom I am indebted for photographs of both, and the other for the use of Mr. C. A. Harrison, the engineer of the line. Mr. Worsdell's engine, No. 66 (Figure 2), is an old engine very much altered. Until a short time back this had a leading bogie and the single carrying axle was trailing; it had a copper-topped chimney and a neat front

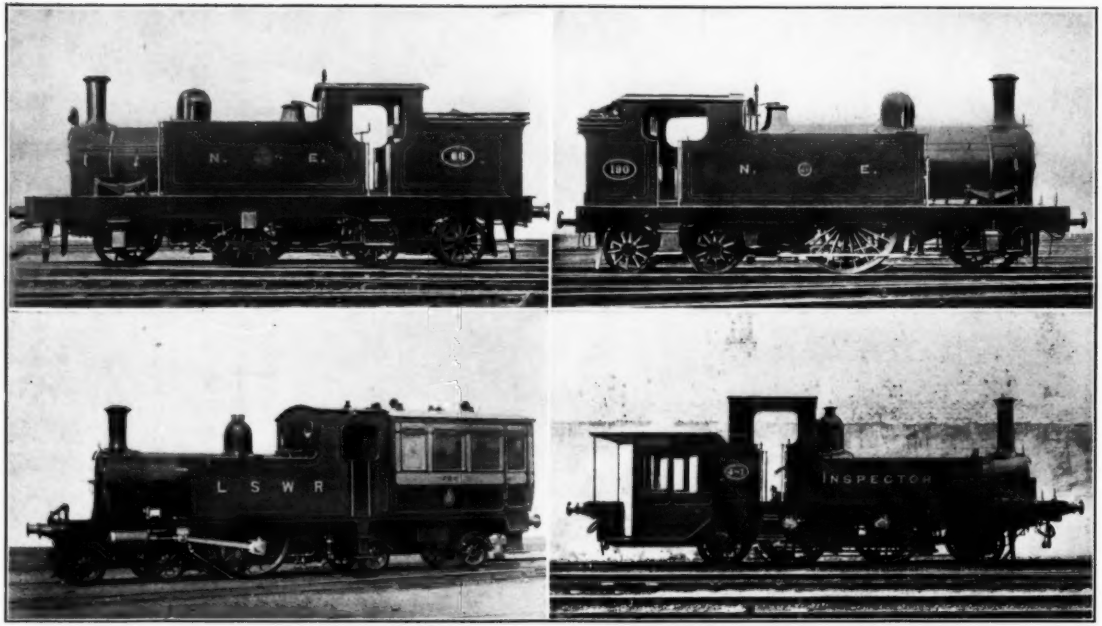


FIG. 2. MR. WORSDELL'S INSPECTION ENGINE, N. E. R.
FIG. 5. MR. DRUMMOND'S INSPECTION ENGINE AND SALOON, L. & S. W. R.

FIG. 3. MR. HARRISON'S INSPECTION ENGINE, N. E. R.
FIG. 4. OLD INSPECTION ENGINE, WITH COUPÉ ON ENGINE FRAME, L. B. & S. C. R.

frame extension, which, together with the bright brass axle-box castings still upon it, gave it a handsome and striking appearance. Recently, however, it has been rebuilt, as illustrated, the leading bogie and trailing axle being transposed, and a larger bunker provided, the engine being also otherwise altered to conform more to North Eastern practice. Mr. Harrison's engine, No. 190 (Figure 3), has all along possessed the same wheel arrangement as No. 66 now has, and was, I believe, specially built. No. 66 has 6-feet driving wheels, and No. 190, 6-feet 6-inch wheels. In work, a single saloon with the rear observation platform is hauled. I have been informed that either of these engines can be started three minutes in front of the fastest express on the line without risk of causing delay to it.

A good many years ago the late Mr. Stroudley rebuilt an old tank engine belonging to the London, Brighton & South Coast Railway, with a rear coupé compartment attached to the engine frame for inspection purposes, and appropriately named it "Inspector." This did good work for a long time, but was broken up a few years ago, since which time no special inspection engine has been in use on this line. I am indebted to Mr. R. J. Billinton, the present locomotive chief of the line, for the interesting and valuable photograph from which Figure 4 is prepared.

A very similar machine was, and may be still, in use on the North British Railway, but this I am unable to illustrate.

To Mr. Dugald Drummond, the able motive-power chief of the London & South Western Railway is due the only specially designed absolutely modern inspection engine in England, and this is shown in Figure 5, photograph having been kindly supplied by the designer for the purposes of this article.

This pretty little combined engine and saloon has 5-feet 6-inch single driving wheels, and has in addition a leading engine bogie and a long-wheel-base bogie supporting the saloon portion. In the front section of the saloon there are two small compartments—one for an attendant who can communicate with the driver through the opening which can be clearly seen in the illustration, the other being a well-fitted lavatory. The saloon itself will comfortably accommodate about eight persons. I can vouch for the excellence of its design and fitting-up by personal inspection. A special shed is provided for it at Nine Elms locomotive depot, and by the officials there it is considered the "pet of the line."

On all other British railways, so far as I am aware, no specially designed locomotives are employed for inspection purposes, though

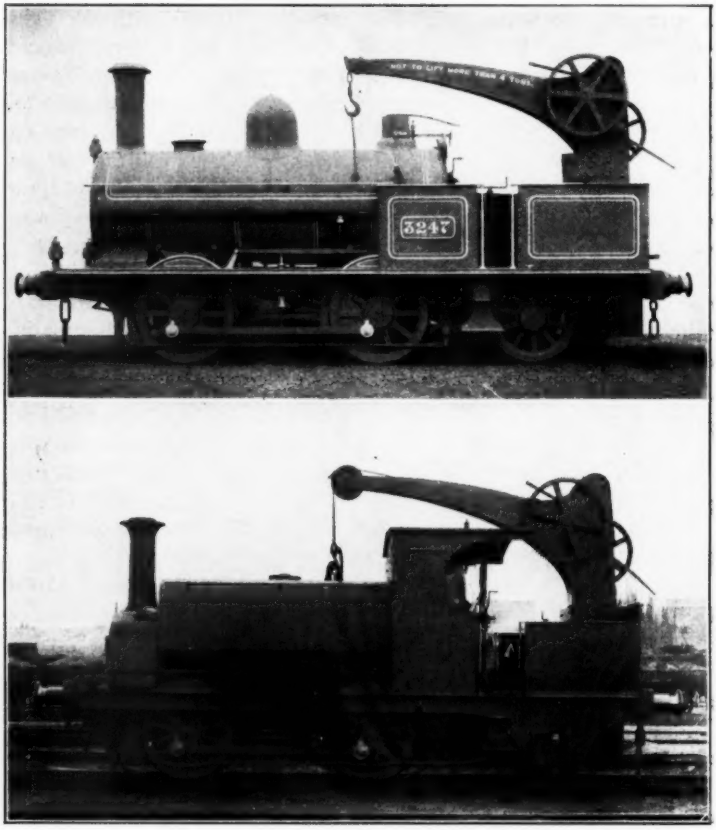


FIG. 7. LOWER PICTURE. CRANE LOCOMOTIVE, NORTH LONDON RAILWAY.
FIG. 6. UPPER PICTURE. CRANE LOCOMOTIVE, L. & N. W. RAILWAY.

Engine cylinders 14 inches diameter by 23 inches stroke; coupled wheels 4 feet diameter; trailing wheels 3 feet 6 inches diameter; wheel base, total, 14 feet 9 inches. The crane is capable of lifting 4 tons, and is worked by two steam cylinders, each 4½ inches diameter and 6 inches stroke. It is easily worked by the driver, who can with one lever raise or lower a load as desired. The lifting speed for light loads is at the rate of about 50 feet per minute, and for heavy weights about 14 feet per minute.

in some cases particular engines, usually old ones, are reserved for hauling the official saloons. Thus, on the Caledonian Railway, No. 123—Mr. Drummond's 7-feet single express engine, whose exploits in the 1888 race to Edinburgh are still remembered—is ordinarily used for inspection purposes, and on the Lancashire and Yorkshire Railway, two 6-feet 6-inch four-coupled engines belonging to a class now too weak for main-line work are generally employed.

The crane locomotive is a very useful combination machine, of which representatives are owned by several British railways. Such engines are only exceptionally used on the running lines of a railway, as they are intended for use about the works and in shunting yards, but they are often sent out with the "breakdown" train, unless the distance to be travelled is considerable or the accident is serious and it is necessary to send a big crane. By this means the ordinary crane which forms part of the breakdown train can in many cases be dispensed with. The crane locomotive is also very useful for working permanent-way or relaying trains.

In the usual way, the crane engine is used for shunting or in conveying parts from one shop to another at the works; but when lifting is required, sometimes in loading and unloading its own train, the crane portion can be quickly and conveniently brought into use without it being necessary to fetch an ordinary crane.

Figure 6 illustrates the London and North Western crane engine as used at the Crewe Works. The coupled wheels are 4 feet in diameter and the locomotive cylinders 14 inches diameter and 20 inches stroke, the coupled wheel base being 8 feet 3 inches, total 14 feet 9 inches. The crane is capable of dealing with loads up to 4 tons and is worked by two steam cylinders, supplied from the locomotive boiler, each 4½ inches diameter and 6 inches stroke. The lifting speed for light loads is at the rate of about 50 feet per minute, and for heavy weights about 14 feet per minute. The crane is easily worked by the driver, who can with one lever raise or lower a load as desired.

It will be noticed, on examining the photograph, that between the coupled wheels, rods are fitted; these when pressed downward grip the permanent way, thus giving the necessary stability when the crane is in use.

In Figure 7 I am enabled, by the courtesy of Mr. Price, the locomotive superintendent, to illustrate the North London crane engine. This diminutive machine, for it is very small, is yet a very useful engine. The engine is of a type which has long since ceased to exist on the North London Railway, and is a characteristic example of the utili-

sation of an old machine which would otherwise have been scrapped long ago. This engine is also noteworthy because of the fact that, as will be seen from the figures, equalising levers are used for the coupled wheels, this being a practice usual in America, but not in great favor in Great Britain.

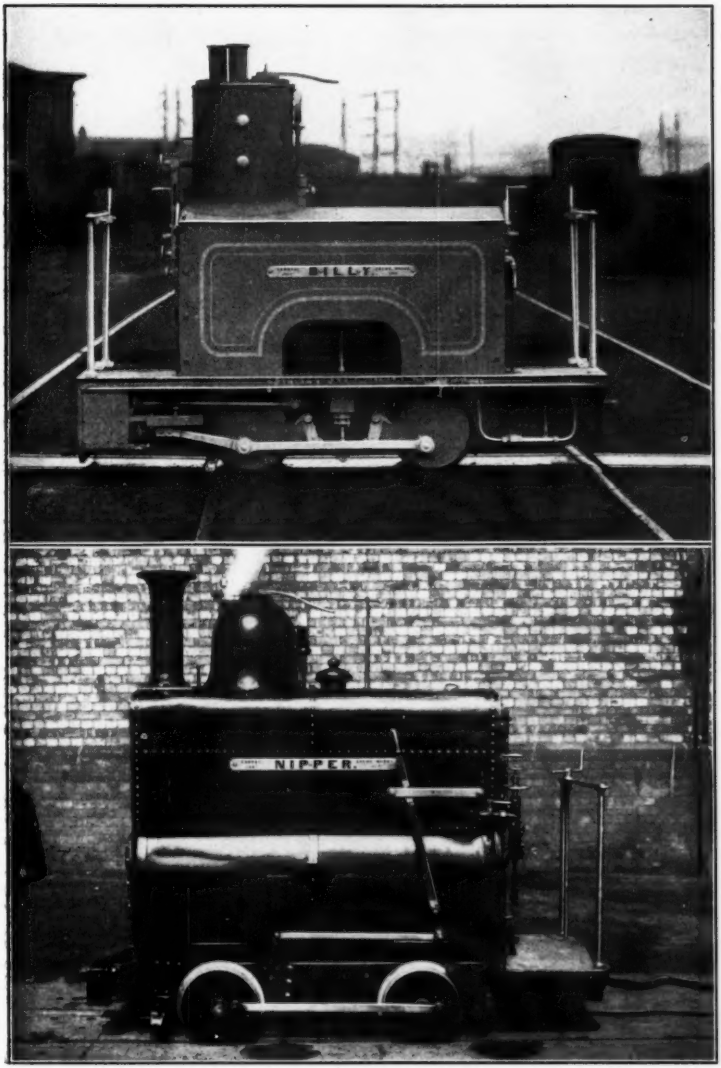
The Great Eastern Railway possesses three crane engines, all stationed at Stratford, and known as "C," "D" and "E" respectively. The Lancashire & Yorkshire Railway also possesses one or more of these useful machines.

In a big locomotive works there is constant necessity for the conveyance of material from one shop to another, so that many of the more important British railways have built locomotives specially for such service. Figure 8 illustrates one of the first "works" locomotives, designed for use on the very extensive lines of 18-inch gauge which are laid throughout the Crewe Works of the London and North Western Railway. This locomotive and its fellows are queer-looking machines but are, nevertheless, very useful. The design dates bach to 1862. The cylinders are 4½ inches diameter and 6 inches stroke, the coupled wheels being 16 inches in diameter, and the wheel base 3 feet.

It is one of these engines which is represented in one of the two well-known locomotive versions of Landseer's picture, "Dignity and Impudence," standing alongside "Cornwall," the old and famous 8-feet 6-inch single driving express engine; the other is a photograph showing a somewhat similar engine belonging to the Lancashire and Yorkshire Railway (to be described hereinafter) next to one of the big four-coupled engines.

Since the engines of the "Nipper" class were built, Mr. F. W. Webb has designed another class of engine for the Crewe narrow-gauge lines, and Figure 9 illustrates one of these. As will be seen, these locomotives are peculiar in design: they are double-ended, and can be driven from either end, and the chimney, in two sections, passes up through the steam dome itself. The outside cylinders are 5½ inches diameter with a 6-inch stroke, and the coupled wheels are 16 inches in diameter spaced 3 feet apart. The first of these was designed in 1875. In the photograph the brake gearing, operated by a small steam cylinder, is very clearly shown.

It is generally agreed that the Crewe Works are the most complete in the world, but the works of the Lancashire and Yorkshire Railway at Horwich, though smaller, constitute a good second, and as they are of comparatively recent date and specially designed for the requirements of a big railway, instead of having grown in the course of many



FIGS. 8 AND 9. NARROW-GAUGE LOCOMOTIVES USED IN THE CREWE WORKS, L. & N. W. R.

The lower one (Fig. 8) is the older type.

years from a small beginning, they are probably more convenient and orderly though less extensive and complete than those at Crewe. At Horwich, also, are many miles of 18-inch tramway, on which work strange-looking little engines conveying material from one shop to another. One of these engines is illustrated in Figure 10, the photograph having been kindly supplied by Mr. H. A. Hoy, the locomotive superintendent of the line. These locomotives were designed by Mr. Aspinall, the late motive-power chief, and now the general manager. The leading dimensions are as follows:

Cylinders	5 inches diameter, 6 inches stroke.
Wheels	16¼ inches diameter.
Boiler: diameter	2 feet 3 inches.
length	5 feet 2 inches.
Firebox: length inside	2 feet 3¼ inches.
diameter inside	1 foot 5⅞ inches.
Tubes (54), outside diameter	1 7-16 inches.
Heating surface: tubes	40.64 square feet.
firebox	7.22 square feet.
grate area	1.78 square feet.
Weight in working order	3 tons, 11 cwt., 2 qrs.
Tank capacity	76½ gallons.

Figure 11 illustrates another London and North Western engine which though not exactly a works engine, must be included in this section. It represents an engine of a class which is very useful in big shunting yards. The gauge is, of course, in this case standard. The chimney passes up through the steam dome, thus giving the engine a very un-locomotive-like appearance, and provision is made for operating from either end. The coupling rod of bar construction is worthy of notice. The wheels are 30 inches in diameter, and the cylinders are 9 inches in diameter with a 12-inch stroke. The total weight in working order is 15 tons 3 cwt.

The remaining engines to be described belong to the orthodox and money-earning classes, but are special in that they are designed for particular uses and with regard to particular requirements.

The four-coupled shunting engine shewn in Figure 12 was designed by Mr. Webb specially for shunting operations in private sidings and yards connected directly with the L. & N. W. R. system where the curves of the lines are often, of necessity, very sharp—so sharp, indeed, that it is almost impossible for an ordinary locomotive to go round them without risk of derailment. The peculiar feature of this engine is the trailing carriage for the rear wheels. The axle is mounted

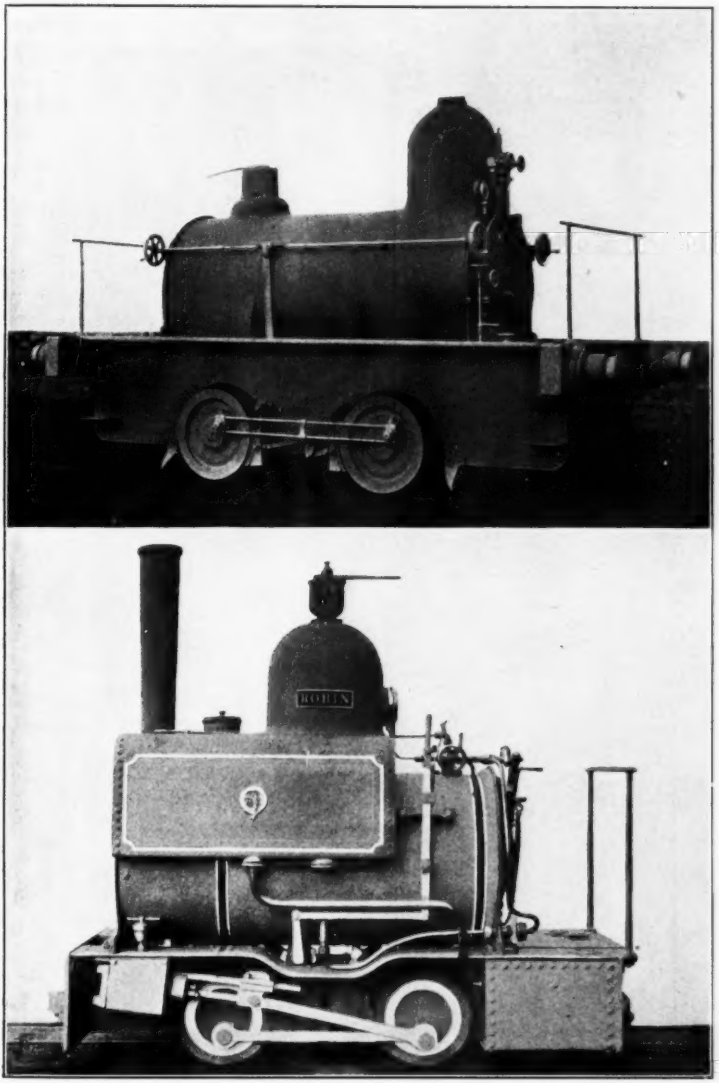


FIG. 11. UPPER PICTURE. STANDARD-GAUGE, YARD SHUNTING ENGINE, L. & N. W. R.
FIG. 10. LOWER PICTURE. TRAMWAY ENGINE, 18-INCH GAUGE, LANCASHIRE & YORKSHIRE RAILWAY.

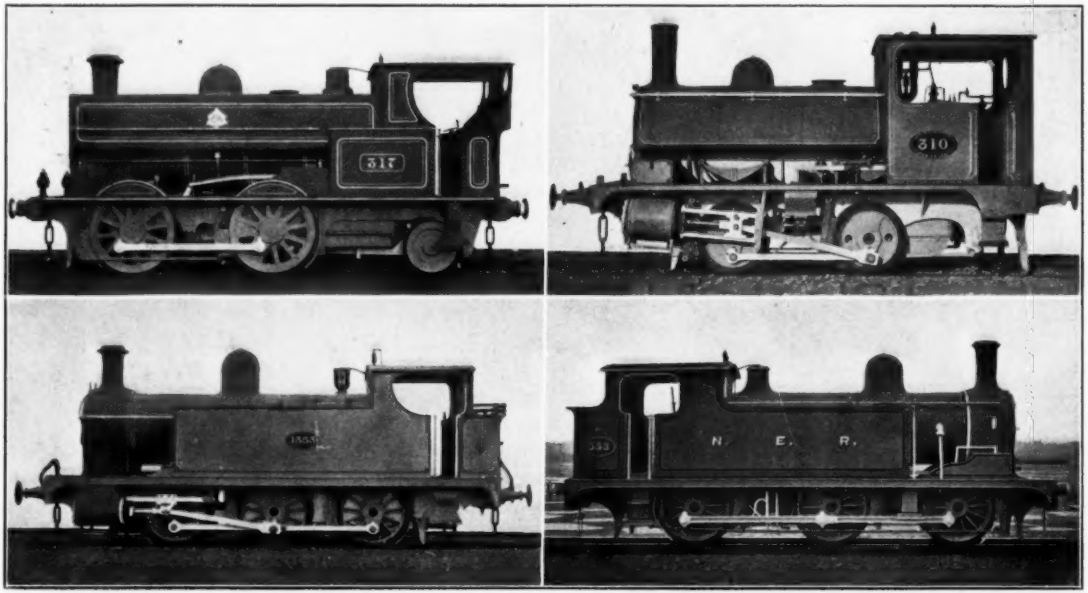


FIG. 12. FOUR-COUPLED ENGINE FOR SHARP CURVES, L. & N. W. R.
FIG. 13. FOUR-WHEELED SHUNTING ENGINE, L. & Y. R.
FIG. 14. SIX-COUPLED SHUNTING ENGINE, L. & Y. R.
FIG. 15. STEEP-GRADIENT BANKING ENGINE, N. E. R.

in a frame which is pivotally connected to the engine frame at a point some distance towards the front, so that the axle can readily take up positions angular to the coupled axles, and thus the wheels can accommodate themselves to very sharp curves and to irregularities in the road to an extent which is impossible in the case of ordinary locomotives. The following dimensions will be of interest:

Wheels (coupled).....4 feet 3 inches diameter.
(trailing) .....2 feet 6 inches diameter.
Wheelbase (fixed).....7 feet 3 inches.
(total) .....15 feet 6 inches.
Cylinders .....17 inches diameter, 24 inches stroke.
Weight in working order.....34 tons, 17 cwt.
Weight available for adhesion.....14 tons.

Figure 13 illustrates a useful Lancashire and Yorkshire shunting engine of a type which is used in the big shunting yards, and Figure 14 illustrates a larger engine such as is used for shunting both in goods yards and at passenger carriage sidings, and also for local goods service.

The leading dimensions of these two engines are as follows:—

	4-wheels coupled engine.	6-wheels coupled engine.
Cylinders: diameter	13 inches.	17 inches.
stroke	18 inches.	24 inches.
Wheels (all coupled) diameter	3 feet 3⅛ inches.	4 feet 6 inches.
Wheelbase	5 feet 9 inches.	12 feet.
Weight in working order	21 tons 5 cwt.	50 tons.
Boiler: diameter	3 feet.	4 feet 2 inches.
length	8 feet 10 inches.	10 feet 4¾ inches.
Firebox: length	2 feet 10 inches.	5 feet 6 inches.
width	3 feet 9 inches.	4 feet 1 inch.
height	4 feet 3¾ inches.	5 feet 1 inch.
Tubes, diameter (outside)	1¾ inches.	1¾ inches.
number	104.	220.
Heating surface: tubes	432.75 square feet.	1081.5 square feet.
firebox	43 square feet.	85.9 square feet.
firegrate	7.2 square feet.	17 square feet.
Tank capacity	450 gallons.	980 gallons.
Coal capacity	14 cwt.	2 tons.

In addition to the locomotives above described there are, of course, many engines which are specially designed, say for working heavy and fast express trains over particular sections of the line, or for dealing

with very heavy goods or mineral trains, but these are strictly outside my subject.

I, however, illustrate, in conclusion, by Figure 15 a large North Eastern tank engine designed for working over very steep gradients. These engines were designed by Mr. T. W. Worsdell, the late locomotive superintendent, for banking on two of the most difficult inclines on the system, the one at Redheugh (Gateshead) with a gradient principally of 1 in 22 connecting the extensive mineral lines on the south side of the Tyne in the district known as the "Teams" with the main lines just by Gateshead station, and the other on the north side of the river close by the Manors station connecting the Quayside lines with the main lines. The latter of these lines is partly in tunnel, and the gradients in both cases necessitate very severe work on the part of the locomotives. I have seen mineral trains ascending the Redheugh incline with two ordinary six-coupled goods engines in front, and one of these big tank engines at the rear, all working at full power. These tank engines are little known and are rarely seen by passengers, for they work on sections which are devoted entirely to goods and mineral traffic and are removed from the main passenger lines. I am unable to give the dimensions of these powerful engines.

There are a few other locomotives in Great Britain which come within the purview of this article, but sufficient has been said to show that the locomotive engineer is not alone concerned with the designing of engines for working passenger and goods traffic, but has also to design, occasionally, special locomotives, of which the principal and most interesting examples have been set forth above.

I would express my thanks to the various locomotive superintendents who have so kindly furnished particulars of their special locomotives as described above, and for the photographs, all of which are official, with which this article is illustrated.

THE POWER PLANT AND MECHANICAL EQUIPMENT OF APARTMENT HOUSES.

By Percival Robert Moses.

The apartment house, as it has been developed in the United States, is a really remarkable assemblage of engineering appliances and processes, requiring the exercise of an equally comprehensive range of engineering skill in its design and maintenance. Mr. Moses' general definition of the field will be followed shortly by a significant paper by Mr. R. P. Bolton, dealing very plainly with certain abuses of professional ethics in connection with the construction of these plants, for which the architectural profession is responsible and from which the engineer, the owner, the manufacturer, and the public are alike suffering.—THE EDITORS.

THE congested conditions of cities, together with the increased demand for conveniences and comforts, has forced the development of the modern apartment building. The most complete development of the idea of centralization is found in the United States in the so-called apartment hotel, where not only the supplies of heat and light and general service are taken care of by the owner of the building, but the kitchen, laundry, and general care of the individual apartments are also controlled from the same source, and the tenant has only to pay his bills.

The two main divisions of high-class apartment houses are therefore the housekeeping type and the non-housekeeping or hotel type. The buildings of the better class are from ten to twenty stories in height, from one to two stories below the ground, and cover plots from 50 by 100 to 200 feet square. Buildings are finished in some cases by a roof garden enclosed or partly enclosed.

Rooms are heated by steam radiators, and in one or two instances by hot air, delivered from a forcing apparatus in the basement, through ducts to the separate apartments and halls. They are lighted by electricity, lights being grouped in clusters in the center of the rooms and at localized points on the side walls and partitions. Electric bells from the rooms to a central point in each apartment, and from front and service doors and from tables in the dining rooms, are installed and operated from a central point by a small dynamo in the basement. Hot and cold water are supplied to all bath rooms, kitchens, and frequently to the separate rooms, although the tendency is to place bath rooms between pairs of rooms, doing away with the individual wash stands. In one large apartment, filtered salt water will be supplied for baths.

Provision must be made for removing waste of all kinds, such as garbage, papers and refuse. High-speed elevator service is of course a necessity, and the elevators are divided into passenger elevators for the service of the tenants and their friends, and service elevators carrying the servants, tradesmen, and luggage. Mail chutes are provided, so that letters can be mailed at each floor by merely dropping them into a slot; and in some buildings pneumatic delivery tubes carry mail, newspapers, small parcels, and visiting cards to the separate floors, whence they are delivered to the tenants. Each apartment has its telephone connected to a central station on the first floor, which connects it with the general telephone system of the country.

In housekeeping apartments, gas is supplied for cooking, each tenant paying directly for this, or in one instance electricity for electric cooking apparatus is supplied at a fixed charge per month. Cold-storage boxes are placed in each pantry, and these are cooled by salt or calcium brine circulated through coils in the boxes by pumps in the engine room, the brine being maintained at a temperature of from 0 to 10 degrees F., and frequently fresh water cooled to 40 degrees F. for drinking purposes is circulated. As the tenants have part of their laundry attended to by their own employees, washing facilities are provided in the basement with tubs, clothes boilers heated by steam supplied from the plant, and electric or gas-heated irons.

In the hotel apartment, as there are no kitchens in the individual apartments, steam is supplied to one or more main kitchens for cooking and other apparatus; large cold-storage refrigerators are cooled in the same manner as the small ones in housekeeping apartments, and ice is made for table and other uses. The laundry apparatus is operated mechanically, usually by electric motors, and includes steam-heated mangles for ironing, centrifugal driers, etc. The main kitchens are equipped with bains marie, vegetable and stock kettles, plate warmers, dish-washing machines in which the dishes are lowered and raised in wire baskets mechanically and cleansed by a steam-heated solution, and other cooking apparatus. Occasionally electric-plating apparatus for the plated ware is installed, electric-driven printing machines for printing *menus* and other literature connected with the building, and electric-driven knife-grinding and polishing machines—in fact, everything required for conducting the business of the hotel with the least recourse to outside sources.

The rental value of such apartments is high, and varies from $20 a room per month up to $75 a room per month; the non-housekeeping apartments being naturally more expensive than the housekeeping.

The tenants demand the best service, and every provision must be made to prevent interruption of this service, as a serious breakdown might not only cause heavy loss in rentals, but loss of life.

The heart of these immense buildings is the power plant, and the supply feeders for steam, electricity, water, and brine may be compared to the arteries of the body. The keystone of the power plant is the steam-generating system. This system consists of steam boilers, either of the return-tubular or of the water-tube type. The return-tubular type is generally used for steam pressures of 115 pounds or less, the water-tube for pressures above this. The number of boilers is proportioned to the requirements of the building. There should always be at least one spare boiler, to allow cleaning of the others; but in general the number should be kept as low as consistent with economical use of the fuel during the different seasons, as it is axiomatic that the more pieces of apparatus there are to be taken care of, the more labor will be required to take care of them. Small sizes of steam coal are ordinarily burned under these boilers, known to the trade as pea coal, No. 1, 2, and 3 buckwheat. The last two can be burned economically only with forced draft. The grate surface of the boilers should be proportioned to allow 1 square foot of surface to from 3 to 4 boiler horse power—i. e., about 1 square foot of surface to 100 pounds of water evaporated per hour. It is not the purpose to enter into the details of a boiler specification in the limited space of this paper, but this ratio of grate surface is mentioned as several instances have lately come to the author's notice where the entire equipment has been seriously handicapped by the use of grate surface half the size required by the other proportions of the boilers.

Steam is supplied from these boilers at 100 to 150 pounds pressure, depending upon the size of the plant and the other uses of steam, and is delivered through main wrought-iron pipes to the engines connected to the electric dynamos, steam cylinders of pumps, and at a reduced pressure for heating and other low-temperature purposes. In a paper written for THE ENGINEERING MAGAZINE in October, 1898, entitled "Use of Steam and Labor in Isolated Plants," the best method of using the steam was fully treated. It will be sufficient here to note that the steam is first used expansively in the engines, etc., taking a few per cent. of the heat units available and allowing the pressure to drop from its initial to 2, 3, 4 or 5 pounds as required. This portion of the energy of the steam is used for producing power, after which it enters the heating system, the drying coils in the laundries, and the heater for the water fed to the boilers. In these it loses its latent heat and be-

comes condensed and returns to a receiving tank, whence it is pumped and returned to the boilers, thus utilizing all the heat units obtained from the coal.

Other uses for this low-temperature steam have developed, one of which is in the production of refrigeration, the steam being passed through a distilling retort of the absorption type of refrigerating machine, as will be described a little later.

The steam-pipe system may be said to consist of high-pressure supply, exhaust mains, heating supply and risers, return from heating system, and the drip mains. The high-pressure piping is the one requiring the greatest care, as it is subject to wide extremes of temperature as well as to higher pressure. In general, the standard-weight pipe is amply strong for any pressure up to 150 pounds, but for all pressures above 100 pounds and for pipes larger than 4 inches in diameter, the connections between the ends of pipes or between pipes and valves should be made with extra-heavy flanged fittings. It is my custom to specify that flanges shall be placed on pipes, pipe being brought flush with the face of the flange and then peaned over to make a tight joint, after which the whole is placed in a lathe and the face of the flange trued up. It is a good thing to have these flanges fitted with male and female rings for the higher pressures. For pressures under 100 pounds where the pipe is long the joints should be flanged, but the flanges need not be extra heavy. Connection by couplings for high-pressure work on long lines is distinctly bad practice, as once a serious leak develops, it is impossible to make it tight without taking down the whole main. For low-pressure piping, the standard-weight pipe and fittings are satisfactory. Wherever a branch is taken from a main, whether it be high-pressure, low-pressure, or drip, it should be valved close to the main; otherwise if a leak develops the whole main must be shut off to make the repair, and power plants of some of the largest buildings have had to be shut down completely, merely to allow a drip pipe of the high-pressure main to be repaired.

In order to avoid the possibility of shut-down, due to accident in the main steam connections, the best practice requires an auxiliary main, entirely distinct from the larger main, connected to all the apparatus required for emergency use. It is not necessary usually that this auxiliary main should be connected to all the apparatus, but only to such portions thereof as will be needed for operation for a few hours, pending repair of the large main. Entrained water is most frequently the cause of trouble in high-pressure piping, and can be prevented only by the most careful dripping at frequent intervals. In dripping a long

main, the drips from opposite ends of the main should not be connected together, except through separate traps, otherwise the reduced pressure at the end of the main will not be sufficient to force the drip back against the pressure at the other end, and water will accumulate.

Proportioning the steam pipes leading from the boilers to the engines and other apparatus is of great importance for the economical operation of the plant. At the same time, in high-pressure piping the limits between good practice and the least size that will do the work are quite large, and in one instance where a main 12 inches in diameter was required for proper operation, a 7-inch line was installed temporarily and did the work satisfactorily, although of course with heavy drop in pressure. The size of the pipes is determined by the allowable velocity of the steam in them, and this will be influenced largely by the number of bends, the length, the danger of entraining water from the boilers, and the character of the engines which they supply. As is well known, a right-angle bend in a pipe offers as much resistance as several hundred feet of straight pipe, and certain types of high-speed engines operating under rapidly varying loads will have a greater tendency to pump water over from the boilers than a slow-speed engine operating under steady conditions.

All piping, high- and low-pressure, must be insulated and supported. Insulation for high-pressure piping cannot be too good; in addition to the insulating qualities of the material, its power to resist vibration and high temperatures are important. Low-temperature piping can usually be insulated sufficiently well with some form of covering containing dead air spaces. In supporting the pipes it is necessary to provide for expansion and contraction, and at the same time prevent any vibration being transmitted to the steel structure of the building. It is best practice to combine a system of standards supporting the pipe from the floor with hangers insulated from the beams on which they hang by wood, etc. The exhaust main takes steam from the engines and other high-pressure apparatus using steam, and carries it to convenient points for use as before described. In order to use this steam successfully without damage to other apparatus, it is necessary that all or nearly all of the oil taken by the steam from the cylinders of the engines and pumps should be removed. Part of the exhaust steam from the plant is used for heating the feed water for the boilers. This work is performed either by allowing the exhaust steam to come into direct contact with the water, or allowing the water to flow through a coil, steam remaining on the outside and transferring its heat. The disadvantage of the latter system is that the condensed exhaust steam

is wasted as well as part of its heat. The advantages are that the oil in the exhaust steam is absolutely prevented from entering the boilers, and the pumps handle the water before it enters the feed-water heater, hence in a cooler condition.

The heating system consists of mains from which steam is supplied to rising lines running up through the various apartments. In some cases where it is advisable these mains are run around the upper story, but usually they are placed in the basement or sub-basement. The systems of distribution are known as single-pipe and two-pipe, up and down feed. The essential difference is that the single-pipe system allows condensed water to run back in the same pipe that supplies the steam, and has one valve to shut off each radiator, while the two-pipe system has a separate line to drain off the steam condensed, and has a valve on the supply and a valve on the return for each radiator. In both these systems the air entrapped in radiators is relieved either through automatic air valves discharging into the room, or in best practice through air valves discharging into air lines which are carried to the basement and discharged at a convenient point. Where air valves discharge into the rooms they must be provided with a float preventing the discharge of water as well.

The single-pipe system is the least expensive to install, and if correctly designed it is satisfactory. The main requirements are to have the pipes amply large, to have as few bends as possible, and to have connections to radiators as short and direct as the necessities for allowing for expansion will permit. In other words, everything must be done to keep the velocity of the steam low. If the velocity of the steam is increased beyond well defined limits, water will be held in the radiators, and there will be a continual gurgling and hissing sound accompanied by water hammer. For tall buildings, where the condensation in risers is likely to be large, each riser should be separately dripped by a large drip at its foot, and these drips delivered to the return main, and from there run along the ceiling of the basement or under the floor. In the first case it is called dry return, and the second case sealed or wet return system. The latter is preferable where the pipes can be protected from corrosion and where conditions as to levels permit. The dry (or overhead) system, brings the pipes low in the rooms in the basement, and does not relieve the system as well as the sealed return. In the overhead system the drips from the risers leading to the return main must have check valves permitting the condensed water to flow only toward the return main. These check valves are liable to stick or to be held by excessive pressure in the return main, in which

case the water of condensation will not be relieved from the riser and the system will be noisy; besides the checks themselves will cause a clicking which is transmitted through the risers to the apartments.

Where the building is large, it is sometimes advisable to install systems of heating in which a vacuum is maintained on the returns or the air lines. The systems are patented, and their main function is to reduce the back pressure to nothing, and to insure more perfect circulation of steam by removing the air and water. Where a vacuum is maintained on the returns, the size of supply and return pipes can be greatly reduced.

The required radiating surface in the room is determined from the quantity of glass surface, the exposed wall surface, and the cubic contents, taken in conjunction with the thickness of the walls and the exposure. The most important factors are glass surface and exposed wall surface. These constants have been determined empirically, and must be modified according to the care with which the buildings are constructed. A few points worth noting in the design of such systems of heating are that angle valves with removable soft seats should be used on radiators wherever it is at all possible; risers should have drip pockets provided so that the dirt which accumulates can be taken out, this applying to the air lines and returns as well as to steam supply; connections should be left where they can be reached, and wherever risers are concealed in walls, they should be insulated; radiators should be put near the most exposed surfaces, but for reasons other than heating reasons, it is preferable to keep them away from windows; provision should be made for draining out the returns after the winter season.

The engines used in apartment houses are usually high-speed, from 225 to 300 revolutions, depending upon size, and are directly coupled to dynamos. They are equipped with sensitive governors which hold the speed constant within 1½ per cent., even under momentary changes of load of from 50 per cent. to 75 per cent. of the rated capacity, with self-oiling bearings with removable shells, cylinder lubricators, gravity oiling systems by which the oil is fed to the moving parts, filtered, and pumped back ready for use again, and indicator piping. In some of the larger houses it is found economical to install a few compound engines operating at 125-pounds pressure, but in general the simple engine using the steam in one cylinder is installed. Slow-speed engines, while highly economical, require too much space. If there is room enough, and the conditions warrant, they are preferable to the high-speed engines. Three or more engines should be installed, any

two being capable of carrying the full load which they will be called upon to supply; and this load can be taken as about three-quarters of the total connected installation. During the day one of them can be run, as the day load seldom reaches one-quarter of the maximum.

The supply of electricity in these apartment houses is usually obtained from dynamos directly coupled to high-speed engines without any auxiliary connection to street service, hence it is usual to have one or more spare units as in the boiler plant. Where the elevators are operated electrically, the electricity for light and power may be supplied from the same dynamos without any objectionable flicker in the lighting as the elevators start and stop, provided that the elevators are designed to keep the starting current down to the minimum required by good practice, and that the governors of the engines are of the inertia or similar type which counteract, before the actual drop occurs, the tendency to drop in speed as the load goes on.

From the dynamos electricity is delivered over insulated wires or cables to a switchboard. The switchboard is the receiving and distributing center of the electric system; it receives the electricity from the source, the instruments on it measure the quantity and pressure, and the switches control the different mains and feeders running to distributing panels on the various floors or at other convenient centers. Protective devices designed to prevent overload are located on this board. Distributing panels are miniature switchboards usually containing one switch for each circuit, the whole contained in a slate or metal-lined box and this in turn enclosed in one of wood. Where electricity is to be sold these panels are designed with meter loops.

Good practice requires that the wires shall be protected by metal pipes, which prevent mechanical injury, but do not insulate. In wiring a building, the system of pipes is first installed complete, pipes running from a location near the switchboard to wooden boxes on the different floors, and from these boxes to metal boxes called outlet boxes located wherever lights are desired; after this the wires are drawn in. Wires from the switchboard to the distributing panels are termed mains; wires from the distributing panels to the outlets are circuits. The circuits for lighting are usually two wires encased in a common insulating covering and controlled at the distributing panel by small switches, twelve lights of 16 candle power being allowed on a single circuit, the object of this subdivision being to prevent trouble on one set of lights from affecting all the others. In order to facilitate the turning on and off of lights, switches operated by push buttons are universally installed at a convenient height near the entrance of the room, and are connected

to allow any desired group of lights to be turned on or off by pressing a button. Where it is desired to control groups of lights near fixtures, pendant switches operated by push buttons are used, or switches are installed on the fixtures themselves.

All mains and circuits are protected from possible overload; i. e., from carrying more electricity than their size will safely permit, by strips of fusible metal known as fuses. These fuses are sometimes exposed and sometimes enclosed in cartridge-like cases. When the latter are used they should be designed to indicate whether the fuse is still intact. The safe limit of carrying capacity of wires is not fixed by the point at which the copper will melt, but by the rise in temperature the rubber insulation will stand continuously without deteriorating.

In distributing electricity, the same principle holds true as in steam or water. There is a drop in pressure, depending on the distance from the source of supply and on the size of the supply lines. Both from a viewpoint of economy and of obtaining good light throughout the building, this drop in pressure must be kept as low as conditions of cost will permit. It is usual and proper to allow 3 per cent. loss to the distribution panels under conditions of maximum load, with a maximum to the farthest light not to exceed 4 per cent. With any greater drop in pressure than this, the difference in the pressure between the lights near the switchboards and those farthest away would be very noticeable. On account of difficulties in the design of incandescent lamps for voltages higher than 120, this pressure is usually adopted for private plants in apartment houses. Lamps are designed for higher pressures, but economy or life of the lamps is sacrificed.

Three approved systems are in use for distributing, viz., two-wire 125-volt direct-current, three-wire 125-volt direct-current, and three-wire 240-volt direct-current. The first should be used where no outside service is required; the second, where outside service will be required for lighting only; and the third where outside service may be required for lighting and power both alternately with the plant. In the two-wire system, two wires of equal size are run together, and there is a difference in pressure between them tending to cause a flow of electricity of from 110 to 125 volts. In the three-wire 125-volt system, three wires are run, one having double the carrying capacities of the others; i. e., it is really a two-wire system with one of the wires split in two; in the three-wire 240-volt system, three wires of equal sizes are run together, and there is a difference in pressure between each outside wire and the middle wire of 110 to 125 volts, and a difference in pressure between the two outside wires of 220 to

250 volts; this cannot be used with 125-volt dynamos unless two of them are connected together. When this last system is used, the dynamos are designed for 240 volts, an automatic electric balancing device being used to keep the pressure between each outside wire and the middle wire equal. As this introduces another piece of machinery, it is advisable only where outside service for power and lights is probable. Where electric elevators are used a storage battery is frequently advisable, performing a function similar to that of a pressure tank in a hydraulic-elevator system. It has the additional function of an emergency supply in event of breakdown. Where electric elevators are not used, the cost of the battery usually makes its installation inadvisable.

Dynamos should be compound-wound, designed to raise the voltage automatically from 3 to 5 per cent. as the full load goes on. They should deliver their full capacity with a maximum increase in temperature of not more than 40 degrees C. The revolving part should be secured to the shaft by keys; set-screws are not sufficient. The commutator should be made of heavy copper bars well supported throughout their length, these bars insulated by mica and protected on the inside from any oil that may be thrown up from the engine. The slots in the armature to hold the wires should be shallow, as deep slots cause singing noises. The dynamo should be easy to inspect in all its parts, particularly around the commutator end. The brushes which collect the electricity from the commutator should be of carbon, free from hard spots, and have 1 square inch area for each 35 amperes of electricity delivered at full load. The same holds true of the elevator motors, as these are subject to heavy shocks in starting and stopping, and for this reason in the elevator motors the connection between the wire on the armature and commutator bars should be made flexible. Connections to the elevators from the switchboard should be separate from the lighting connections and separate from each other, otherwise the starting and stopping of elevators will seriously affect the running of the others and the operation of lights.

Switchboards should be of enamel slate, or, where finish is important, of marble, and should have enclosed fuses on the face of the board, an ammeter for measuring current of each dynamo, one voltmeter with a switch arranged so that voltage can be read across all parts of the system, wattmeters to record the total electricity delivered, a standard clock, and the rheostats of the dynamos.

Where electric irons or electric heaters are used, these should be connected with asbestos-covered flexible cable, and should be arranged to cut down the electricity automatically when not in use.

The location of lights and their distribution is frequently decided by the decorative effect. For good lighting one 16-candle-power lamp for from 700 to 800 cubic feet in chambers and 500 cubic feet in dining rooms is ample.

The refrigerating system consists of apparatus for producing liquid ammonia, expansion coils located in tanks to hold the liquor which it is desired to cool, a system of mains and risers through which the cooled liquor is pumped to coils in the various boxes or to ice-water faucets, storage tank for receiving and holding the cooled liquor, and ice-making tank. In order to produce liquid ammonia, two conditions are necessary—first, that the ammonia gas should be raised to a certain pressure; and second that the temperature of this gas should be lowered to a temperature depending upon the pressure; i. e., there is a certain temperature for each pressure at which ammonia gas will become liquid. There are two ways of obtaining this pressure; one is by distilling in a retort in which the required pressure is maintained, and the other is by mechanical compression. The lowering of temperature is obtained by circulating cooling water over coils into which the gas is discharged from the pressure-producing apparatus.

The first type is the absorption system, so called, as the ammonia after expanding in coils of the cooler is re-absorbed by the liquor from which it was originally driven by heating in the still. The latter system is the compression system, and in this the gas returns as gas from the expansion coils of the cooler, and is compressed to the desired pressure. The compression system is the simpler and requires less water than the absorption, but as the water used for cooling the ammonia gas is only heated up it can be used throughout the house, and it becomes a question as to the cost of the water wasted. In general, the water used in winter for the refrigerating machine will always be less than that used in the house. In summer, where the building is a house-keeping apartment, more water will be required for the refrigerating machine than will be used in the house, and the water will be heated up so that it cannot be used as cold water for baths. By properly dividing the water system, a great part of the water required for the refrigerating machine in summer can be supplied to the hot-water system and the waste reduced. In the use of steam, the absorption machine for apartment-house work is far more economical, particularly if it is designed so that distillation can be accomplished by the use of exhaust steam from the engines. No general rule can be laid down as to which is the most economical, but in the majority of cases the absorption machine will be found to cost less to run, balancing losses and gains.

In hotel apartments this is almost always the case, as a great deal more water is used throughout the house in such buildings than in the housekeeping apartments, hence there is less waste of water. The compression machine must be amply large for the work so that it may run slowly and give the valves a proper chance to seat without noise. The noise of operation of the compression machine caused a great deal of dissatisfaction with refrigerating apparatus, but with large machines and proper design, there is no necessity of any noise that can be heard outside of the engine room.

Two methods of circulating brine through the boxes are in common use. In one the brine is forced up one riser and down a return, connection to the coils in boxes going from the riser to the return, as in the two-pipe steam-heating system. In the second method, brine is forced up a single riser and comes back on another riser. At each box a valve is placed in the riser and a branch taken from below the valve on the riser to the coil in the box, and thence back above the valve, thus connecting all the coils in the boxes on the two lines in series, each coil being by-passed by the valve on the riser. This system is more positive and requires less pipe, less valves, and less insulation, where it can be adopted. The objection to it is that it entails more friction and more work on the pump, and greater increase in temperature between the leaving and returning brine. It is particularly adapted to absorption systems, as in these extremely low temperatures on the brine can be obtained with economy. With compression systems, the higher the temperature of the brine the more economical the operation.

One of the most important features of refrigerating work is the insulation of the piping. A great variety of insulations are on the market, many of which work well the first season. Even the best give trouble, unless most carefully applied. If air obtains admittance, either through imperfect sealing of joints or through a break in the covering, the moisture in the air will be precipitated by the cold, and it is only a question of time before the covering will begin to show mildew and rot. The same is true if the insulation allows the cold to be transmitted to its outside covering, making this cold. This results in the deposition on the covering of moisture from the air. Care must be taken in bringing pipes from the risers to the boxes to see that any moisture that collects on the coil in the box shall not be able to run back onto the riser. In general, brine pipes or other cold pipes should be kept out of warm places or enclosed spaces. A free circulation is desirable as it tends to dry off any condensation. The brine piping may be standard wrought-iron pipe. Ammonia piping should be extra-

heavy, fitted with male and female flanges of the very best construction; nothing can be too good for ammonia work. The construction of boxes, brine, and ice-making tanks is entirely a question of cost. The better the insulation, the less expensive it will be to operate the plant. The usual insulation consists of pairs of boards with insulating paper between them, either two or three pairs, separated by spaces containing cork, mineral wool, or other insulating substances; the principal thing is to have the joints tight.

For ice-making, if clear ice is necessary, the water should be distilled and the ice made at a temperature of from 18° to 20° F. Ice about two-thirds clear, enough for most purposes, can be made from ordinary filtered water, provided the temperature can be kept at about 20° F. If a lower temperature than this is used, ice becomes cloudy and marble color. It is usually made in cans containing from 100 to 300 pounds each. Where ice water is circulated throughout the building, the insulation need not be as heavy as for the brine piping. In other respects the work is similar, except that the faucets from which the ice water is drawn take the place of coils. In some cases where it is desired to make ice in the separate apartments, the coil is a box coil, laid on its side, and a shallow pan filled with water is placed in the coil.

It is desirable that complete systems of recording temperatures and pressures should be provided; these include thermometers on the brine and ice-water inlets and outlets, gauges for ammonia, brine, and steam pressures, and salometers and hydrometers for measuring the density of the solutions. The care and operation of the various portions of the plant have been treated in previous papers on the "Determination of Costs" and on the "Systematization of Plant Operation" so these will not be touched on here. It can be readily seen that the best care and knowledge is needed for successful results and incompetence and lack of system must result disastrously.

The question as to design of elevators, the systems of plumbing and water supply, removal of waste and refuse, have merely been mentioned, and it is impossible to take them up here. Sufficient has been written, however, to show the interdependence of the various parts and the immense number of considerations that enter into the design of such equipment. It is similar to the planning of a city on a small scale, and this is not surprising if it be remembered that a building the size of the Ansonia, 200 feet square, seventeen stories above the ground and two stories below, containing three hundred and forty suites of apartments from two to fourteen rooms each, besides stores, etc. on the ground floor, contains during the day from three to four thousand people.

THE MECHANIC OF THE FUTURE, AND HIS TRAINING.

By Egbert P. Watson.

Mr. Watson deals with one of the most pressing problems of the day, so far as the mechanical industries are concerned. "There must be those who are shopmen exclusively; where are they to come from?" The answer proposed by such leading manufacturers as the Westinghouse and the Brown & Sharpe companies were described in our December and January numbers. The systems of the Allis-Chalmers and the Baldwin Locomotive works will follow. Mr. Watson treats the subject on its general merits, from the viewpoint of one long familiar with the practical aspects of the shop, and with relation especially to the scope and effect of the manual-training school.—THE EDITORS.

FIFTY years ago a young man usually looked forward to a trade as his life work, relying upon a thorough knowledge of it for the means of subsistence. To obtain a chance to learn was comparatively easy, for the country needed skilled workers of all classes. It was only necessary for a parent to go to the principals of large shops, vouch for a youth's good character, that he had been to school, and that he wished to learn the trade, for him to be taken on at once as an apprentice. Afterward, his future depended upon himself. He was not bound by articles as in the older times, for employers had learned by costly experience that desirable boys kept their agreements to serve until they were twenty-one; those who were unreliable were not wanted upon any terms. If a boy showed a desire to learn, and was apt, he was rushed forward as fast as possible, and by the time he was of age he could be called capable in all branches of the business.

The young workmen at this stage were not recognized as skilled workmen, to whom any job, no matter how difficult, could be given; but they were fair, all-around men, who could be sent out of the shop to erect or repair work with confidence. They could chip and file details to drawings, and were particularly skillful with the last-mentioned tool. It is needless to say that they were always in demand at the wages paid in the United States at that period—$1.50 to $1.75 per day of ten hours. Thus it will be seen that out grandfathers put in from five to six of their best years to obtain merely a working knowledge of the handicrafts they had adopted. All that was expected of them was to be able to read drawings and interpret their mandates in wood or metal. They were not asked to show diplomas or parchments with degrees attached before they could get jobs; indeed, it was rather against

them than otherwise to be suspected of scholarly accomplishments. What they knew, they knew; a good mechanic in embryo was not metamorphosed into a poor scholar, with a smattering of science and a superficial knowledge of mechanics and machines, to get his living as best he could with such an inadequate kit.

Men like those described blazed a trail through an almost pathless industrial wilderness. They built engines and boilers that did not work to their satisfaction; so soon as they saw the result of their labor, they built other engines which did work. Later on, they improved these until they had reached the confines of their possibilities as mechanics, and then they looked into the theory of things. Here they encountered difficulties at the outset; they were well trained in the solution of problems they could see and handle—tangible things which bound, and jammed, and stuck fast in their grooves, so to call them, because they were too tight, or too slack, or what not. These matters could be aligned and made accountable; but imponderable bodies, inert and unweighable, were an affliction. They were groping in the dark in common with others, for investigators of physics were scarce.

Seeing the field which was open for cultivation, men of experience in the various sciences gave the steam engine special investigation, and there are groups of observers in all civilized countries of the world at work upon it. Armed and equipped with instruments devised for the purpose, and backed by the prestige and support of universities, they have succeeded, aided by designers of steam engines, in diminishing the consumption of fuel to one-fifth of what it was a half-century ago, with a corresponding increase of efficiency. One set of observers supplements the other. The trained observers and the actual workers are of one mind, one accord certainly, in their intents. Technological institutes abound, and the labors of the constructors are lightened by their instrumentality. Some go even further than imparting a knowledge of theory, and combine practice with tools and workshop manipulation. To this last much more weight has been given than its importance warrants—in my opinion. Manual-training schools, so called, where students devote themselves to dexterity chiefly, in the several handicrafts, have their limitations also. At best they are preparatory schools for mechanics of the future, before they enter upon the occupations of their lives. Of the two institutions, the commercial shop and the manual-training school, the former is the best if lasting benefit is to be considered.

Not long ago I visited one of the most important technological institutes in the United States with the object of seeing exactly what the

course was. A professor accompanied me through the shops, wherein the students were attending machine tools after a certain fashion—the fashion which is called "sojering" in commercial shops. That is to say, in a dilatory and uncertain way they were watching lathes nibbling off iron from a casting made for the purpose, a mere "waster" without shape or form, and good for nothing for any purpose.

"What is this young man supposed to be doing?" I asked the professor.

"He is learning the manipulation of a lathe; how to cut iron to the best advantage; to dress, to grind, and to set his tools, and the best speeds to run at."

"At at this particular moment what he is he doing?"

"He seems to be taking a finishing cut," said the professor.

"A finishing cut for what; is he fitting the piece to another casting or only to a certain size?"

"Only to size," said the professor.

"Then he might speed the lathe two steps higher, with advantage," I replied.

"The instructor does not think so," was the answer; " it would burn the tool."

"It might and might not," said I, "but if it did that is just what the young man needs to know—the possible and impossible speeds in turning various kinds of cast iron."

The professor said nothing, and we moved on to other departments where the same vague and general practice was noticed. The latter was not the best, and this I ventured to say to the professor.

"What does it lack?" he inquired.

"The tools are not of the proper shape, and they are ground badly."

"Will you show us how they should be dressed and ground?" said the professor.

"Willingly," was the reply, and taking up a so-called diamond-point turning-tool it was demonstrated that, as then made, it did not cut the metal but rather grubbed it off; by giving the tool side rake and front rake angles were formed which cut on both the rotary motion of the shaft and the lateral advance of the tool, the result being that the surface left was not only noticeably cleaner and smoother to the eye; but, what is far more important, the cylinder was truer—that is, rounder. There were other defects in the centres of the work, but as I did not care to pose further as a demonstrator I made no remarks.

As we passed along to the professor's office he said: "I can see the difference between our work and commercial work, in that in the latter

every man is a demonstrator, and one expert man raises the character of all the others; we have only one expert to teach the students, and as he is so they are."

"Quite true," I responded, "but there is a more vital issue than the one mentioned, which is that there is no incentive for students to do their best or to find the quickest way of doing work. That is what they are supposed to be doing while at college. I believe you do not claim to make expert mechanics by your courses, but rather to familiarize your men by examples in machine work, and personal participation in it, so that later in life, when they are in charge of contracts, they may be able to detect good from bad work, and to estimate closely upon costs. How can they do that with the very slight experience they have had? Five years is usually required of young men in commercial workshops to learn the rudiments of their business, and they are occupied on all sorts of jobs for ten hours a day. Even at the end of their novitiates, their employers would not consider them capable of estimating upon the cost of work, or fitted to criticise it except superficially. It takes years of experience upon the profit and loss sides before men can do this satisfactorily, to avoid losses. I said previously that there was no incentive in your institution for students to put forth their best efforts, and that means there is no competition. When a man's bread and butter and that of his family depends upon his ability to turn out good work in a reasonable time, he endeavors to do his best, to the end that when the evil days come he will be chosen and kept on while single men are left to shift for themselves."

"You must acknowledge, though, that our graduates are in such demand that they can obtain situations at once," said the professor. "If the courses they pursue here are futile, why should manufacturers seek for them?"

"I do acknowledge it, for I know it to be the fact, and nothing that has been said during our cursory conversation is intended to mean that I am opposed to technical education on the broadest lines. Having been brought up, mechanically, in a shop, with only a boarding-school education to start in life on, at a little over fourteen years of age, I know full well the advantages of a technical education, and the difficulties of acquiring one by self-tuition out of working hours. I have had my nose held hard on the grindstone, in this respect, and envy the youth who has an opportunity to be taught the fundamental *principles* of his work. Apprentices of fifty years ago had no such chances. There were no text books even, except a few which were far beyond our comprehension, and we had to rely chiefly upon natural philoso-

phies for what little we could gain from them. In this direction the benefits to be derived from technical colleges are incalculable, and I sometimes wonder whether the students appreciate them fully. I am candid, though, when I say that the shop courses, in so far as I comprehend their aim, are not precisely time wasted, but misapplied. You try to do too much in too short a time. The number of graduates turned out annually from technical colleges is very large; enough inchoate superintending engineers and managers are supplied to run two such nations as ours for some time to come, but where is the mechanic of the future to come from? He is needed now but he is not to be had. In every shop where there is plenty of work the crying need is for capable, all around mechanics."

I am well aware of many firms who, in so far as their own wants are concerned, are educating young men in the principles of machine work, to the end that they may have a reliable staff in stock, so to speak, at all times; but, in the nature of things, this source of supply to the industries of the country at large is inadequate. Moreover, I am not of the opinion that the average young man can drop one thing and take up a wholly different train of ideas with advantage to any one. Brain work and muscle work are unlike in their sequences; the same nerve forces are not on watch. True, one supplements the other to a great extent, and the union of headwork and handwork at the proper times is of benefit, but they cannot be exercised indiscriminately.

It is perhaps uncomplimentary to say this, but hewers of wood and drawers of water are more needed in the work of the world at present than men who are half scholars and half mechanics. A young man who is educated is not contented to stay in a shop a lifetime; he is trying to go up higher; but there must be those who are shop-men exclusively; where are they to come from?

Even the alleged specialists, men who hire out to do one thing only, or shape one piece, are lost in doubt when called upon to do a different detail with the same machine. It is the day of the handy man, who, when all is said and done, is only a first-class laborer. Too much automatic machinery in all trades has put the old time versatile mechanic out of business. Look at the carpenter's trade! It is no longer necessary for him to plough out mouldings, and house "trim" generally. Mills supply such details at a tithe of the expense, and of uniform quality throughout. Sashes and blinds, doors, winding-stair treads, transoms, everything required in a house almost, is delivered at the carpenter shop ready to hang. The same is true of boiler making. Details of all kinds that formerly had to be hand-made can be purchased in open market.

With the advent of hydraulic flanging, the most difficult and critical work the boiler maker had to execute by hand is now delivered as per blue-print furnished, exactly to dimension. All this is of benefit to everyone except the man who has to sell manual dexterity and a knowledge of the limitations of his trade. Not long ago a well-dressed man of, possibly, sixty-five, applied at the office of a celebrated engine works for permission to enter the shops. Visitors were not allowed, as a rule, but the manager, seeing as he supposed only a harmless, inquisitive old gentleman, waived the precept for the moment and passed him in. After an hour or so he was about to leave, with thanks, when the manager asked him, pleasantly, what he had seen.

"I saw," said the visitor; "several things; for one, a man putting tin 'shims' under the guide-bars of a high-speed engine to bring them to line. I saw another man trying to straighten a lot of studs with hot nuts that had been put into holes that were tapped crooked. I saw another man at work upon what he supposed was scraping a plane surface, when he wasn't. I saw nuts screwed onto bolts that they did not fit, so loose that the nuts could be twirled down with the fingers."

The manager was appalled. "You seem to have seen a good deal in a very short time," he said, rather irritably.

"Yes," said the old gentleman, "I did, and I wasn't looking for it either; it was there to be seen; I might have discovered other lapses from mechanical rectitude if I had more time and an inclination to peer into things."

"Who are you?" said the manager peremptorily.

"No one in particular," said the old gentleman; "only a man who served his time a half-century ago and still has a hankering for the shop and all its works; you have a splendid outfit of machine tools and a handy place, but you need a few more conscientious men," and out he went.

"Mr. Professor," I said, "the moral of this does not need a paver's ram to force it into recognition. A man who has not done the same things that he saw perpetrated in the engine shop would not have seen them, or, if he had, would have supposed they were a part of the regular procedure; shims are a venial sin to most persons on machine work, but on high-speed engines, where everything is supposed to be iron and iron, of rigor, they are unpardonable offences. Let me ask, without prejudice, if a student-graduate would have noticed the lapses named?"

"I am free to say that he doubtless would not," was the reply.

"Well, then," said I, "that is my case; I rest here," and with thanks for his courtesy generally, I went out.

Quite recently Professor Hannover, of the Royal Polytechnic, and director of the government testing laboratory, Copenhagen, made a tour through the principal British technical colleges with a view to examining the systems prevailing. His report is extremely interesting to all connected with such subjects, and seems wholly free from bias or prejudices of any sort. Some of his observations may be quoted here, as bearing directly upon the tenor of this article. Also, as might have been expected, it is a strong and well balanced plea for the need of technical education all over the world. I quote only the gist of Professor Hannover's report, not his exact words:—

> The Glasgow University agrees with our Copenhagen Polytechnic, inasmuch as it considers it necessary to acquire workshop practice in real workshops in order to accustom students to deal with time, money, and men. Mr. Goodman, of the Victoria University, objects to teaching workshop practice at all in the college instead of in commercial shops, and the consensus of opinion among British technological institutes generally is to the same effect.

Singularly enough, however, Professor Hannover states that English manufacturers have a great antipathy to graduates of scientific schools and will give practical men the preference in all cases. This would seem discouraging to a large class in England who feel that trade and commerce languish for want of better educated workmen, and a commission is now in the United States, with Mr. Alfred Moseley at its head, to observe the American public schools and see how far the system will apply in Great Britain. Professor Hannover says that in his visits he was struck by the fact that so few of the leading men had received a scientific training. Most of them were practical men who were undoubtedly clever, but having had no other advantages than those derived from the shop and the night school, were fitted only to go on in the old ruts and never to strike out on new lines.

Be this as it may in England, there is need of practical men, by whom is meant those who intend to follow certain trades of their own choice as a means of livelihood, in every part of the United States. With the ban placed by trades unions upon the number of apprentices employers are permitted to engage, it is not wonderful that mechanics are scarce and likely to be scarcer in time to come. Richter (Johann Paul Friedrich) said two centuries ago:

> "Every man has two educations—that which is given him, and the other that which he gives himself. Of the two kinds the latter is by far the most valuable. Indeed, all that is most worthy in a man he must work out for himself. It is that that constitutes our real and best nourishment. What we are merely taught seldom nourishes the mind like that which we teach ourselves."

All of which seems to apply favorably to the old ways of making mechanics.

There are still young men in the United States who desire to learn trades as a means of gaining livelihoods, but they are of a different class from the boys of half a century ago. They are not graduates from high schools, but the sons of laborers, in a majority of cases, who, knowing the benefit of a trade to a young man, and seeing the high wages the skilled workman receives in comparison with men of no trade, endeavor to get them into shops. They enter as apprentices and sign printed forms to serve four years. The first year they receive 50 cents per day, and the last year $1.25 per day, and are then rated as journeymen, free to go where they please. No education of any kind is given them; if they desire to study theory, however, they must do so of their own volition from sources outside of the works. These young men fill a certain demand only; if there were more of them it would be better, but the country grows faster than the supply of shopmen; hence the scarcity.

According to the aptitude of individuals these men are good, bad, and indifferent mechanics, or workmen, but they have acquired a certain position and facility with the routine of commercial shop work, and they fit in somewhere.

It seems to me that an experience of this nature would be much better for young men who have aspirations for professional situations in life than the systems in vogue generally in technological institutes. Candidates for scholarships in them will not be received unless they have had certain preparatory courses in study, prior to their applications, in specific lines; but no stipulations are made as to mechanical ability of any kind, and a regular kindergarten in rudimentary machine work (if I may so call it without disrespect) is established for all who desire to take it. There does not seem to be any reason why scientific colleges should be at the expense of this, particularly when it is of so doubtful value in the scientific course, and of no value at all from a commercial aspect, as I have tried to show in preceding lines. A young man should come prepared in the rudiments of every branch he takes up, machine work included, and in my opinion college machine shops should be abandoned wholly, in the interests of both parties, the students and the faculty. If a young man puts in four years in a commercial shop, during that time he has opportunities for self-examination as to whether he really wishes to follow the profession of a mechanical engineer, or had misconceptions of it. He gets a knowledge of men and methods which he cannot obtain in the college shop, and has a

clearer perspective of his future. On the other hand, he may become so interested in the practical side of machine work as to decide against a scientific course, in which event he becomes a desirable shopman. From an economic standpoint he might do worse. Professions are not mines of wealth; those who have embraced them are not paid in proportion to their merits, anomalous as it may seem. Men have grown gray in the services of colleges without receiving more than a very small salary. Be this as it may, the shopman has by no means a poor outlook in comparison with many of the so-called learned professions—lawyers, physicians, and even clergymen. He can command now $3 per day, and much more if he is a skilled man; on piece and contract work he can make "good money," as the saying is. Few professional men make $3 per day in the early years of their careers, and there is nothing in the calling of any workman to debar him from civic or national honors if he seeks them. The only thing which prevents more young American men from taking up trades is the fancied stigma which attaches to a mechanic, so-called, among a certain class—one, by the way, whose verdict is of no importance from any aspect.

If I had a life to live over I should devote five years to learning a trade first. I would go into a shop without giving any one a hint as to my intentions later, and would take what came, keeping an open eye and receptive mind for all within my field of vision. After such an experience I would go to a scientific school (if not outlawed by an age limit) and absorb knowledge as a sponge does water. As one benefit from this course, I would have a sound mind in a sound body, enabling me to study hard and to appreciate more readily the teachings of science. I could see exactly where it agreed or conflicted with practice.

If I may say so without offence, I have but little faith in certain educational fads which resemble the bed of Procrustes. Those who sought entertainment upon it were cut off if too long and stretched if too short, with, doubtless, disastrous results. Certain courses are to be given at certain times in class, the student-workman dropping his task meanwhile and readjusting his mental faculties to another gauge. It may be that this is feasible, and that some individuals can assimilate what is offered, but as a system it is open to objection. Mr. Josh Billings, holding hilarious and shrewd views of life, said that it was better to know a few things that were correct than so many that were not so, and this applies to professional careers. If a man has a solid foundation under him which he has built up himself with a hammer and chisel, so to speak, he can get at least bread as a workman, when other lines fail.

EDITORIAL COMMENT

THE Panama policy of the Senate minority is a puzzle to the layman. It is not wholly clear to the practical mind how "political capital" can be made by opposing and delaying the Administration in a measure which is so widely popular—so impatiently demanded—as the definite beginning of work on the Isthmian Canal.

To that honest but partly-informed sentiment, however, which can not get beyond a fancied wrong to Colombia, and therefore halts and hesitates to deal with the supposedly guilty State of Panama, we offer the following intimate view of the Panameños before the recent revolution. It is by a distinguished and loyal Colombian, Señor A. Galofre, and appeared in a Bogotá newspaper—*El Relator*—the translation being from a copy which has just reached us. It has therefore a weight which might not belong to any statement coming from Isthmian sources. Spain's treatment of the Cubans, which we held a cause and justification of our armed intervention, was no worse than Colombia's treatment of the Panameños as set forth in Señor Galofre's arraignment of his own country:—

"From owners and lords of the soil, we have converted them into outcasts in their native land. Roughly and unexpectedly we took from them their rights and we suppressed all their liberties. We deprived them of the most precious faculty of a free people—that of electing its governors, its legislators, and its judges. We restricted their suffrage; we falsified the election returns, and we caused the wish of a mercenary army, and a train of government employees, foreign completely to the interests of the department, to prevail over the popular wishes. We took from them the right to legislate, and as compensation we placed them under the iron yoke of exceptional laws. The State, provinces and municipalities lost completely the autonomy they formerly enjoyed. We limited their taxes and their right to employ them. In the really cosmopolitan cities of the Isthmus we have not founded national schools where their children could learn our religion, our language, our history, and the love of our country. Before all the world we have punished their writers with imprisonment, banishment, fines, and the lash, for the innocent expression of opinion. From December, 1844, to October, 1903, presidents, governors, secretaries, prosecuting attorneys, mayors, aldermen, military heads, officers and soldiers, chiefs, inspectors, and adjutants of police, the police itself, captains and port surgeons, magistrates, judges of different categories, comptrollers—all came from the highlands of the Andes or from other parts of the Republic to impose upon the Isthmus the wish, the law, or the whim of the strongest; to traffic in justice, or to speculate with the public funds; and that train of employees, like an octopus with many tentacles, sucked the sweat and the blood of an oppressed people and devoured that to which in fact only the Panameños had the right.

"We turned the Isthmus into a mili-

tary barracks. And when this people of 350,000 souls produced men of continental reputation such as Justo Arosemena, notabilities of the first order and of almost irresistible popularity like Pablo Arosemena and Gil Colunje, men of talent and learning like Ardila, accomplished diplomats like Hurtado, and men celebrated in science and with European reputation like Sosa, we pushed them aside, relegating them to disrespect and forgetfulness rather than giving them positions of influence in the Isthmus. Such prooeedings wounded the pride, the dignity, and the patriotism of all intelligent men of the Isthmus, and fomented and provoked the odium and the hate of the mass of the people.

"We now feel the result of all these errors. The last twenty years have been very bitter and cruel for the Panameños, and they will not wish in the future to be Colombians if they must continue to live under a regimen which does not permit them to be citizens in their own country."

Señor Galofre concludes with the significant exclamation:—"Either Federal government for Panama, or dissolution!" Can anyone believe Bogotá would have granted the Federal government, or that, apart from the exasperation of the rejection of the Hay-Henan Treaty, dissolution would long have been delayed?

* * *

WE HAVE reviewed elsewhere in this issue the valuable comparison made by Professor Cathcart upon the relative merits of water-tube and cylindrical boilers for naval service, and closely upon that study comes the news of the disaster upon H. M. S. Wallaroo, in which four stokers were killed and three seriously injured as the result of an explosion of a cylindrical marine boiler. This event demands comment at this time especially because many of the opponents of water-tube boilers have enlarged upon the fact that a boiler of that type may be disabled in consequence of the bursting of a single tube. That a Scotch boiler is liable to such an explosion as occurred off the coast of New South Wales does not seem to have occurred to its advocates, and fortunately indeed such accidents are rare; but with water-tube boilers they are impossible.

When properly constructed, the shell of a cylindrical boiler is amply strong to resist the internal pressure which it is called upon to bear, while the improved corrugated and suspension furnaces have shown themselves far superior to the older forms, if proper care is taken to prevent accumulation of grease or deposit. There is always a weak place, however, in the Scotch boiler, this being the combustion chamber at the rear of the furnaces, connecting these latter with the tubes. This portion is necessarily of irregular shape and must depend for its strength upon staying, while it bears externally the full pressure of the steam. According to the reports of the explosion on the Wallaroo the stays on top of the combustion chamber gave way, resulting in a collapse, followed by the discharge of the entire contents of the boiler into the stokehold.

By this demonstration of the possibilities of such disasters the case of the water-tube boiler is materially strengthened at this time, and the influence of the accident will doubtless be great. The work of the stoker is most difficult at all times, and with the ever impending possibility of a fearful death before him the task has added severity. Ultimately it is to be hoped that mechanical contrivances will replace human effort in this heavy work, but in the meantime the continued use of boilers which may and do explode should be limited, and the far safer sectional steam generators should be installed.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

COMMERCE AND ENGINEERING.

THE RELATION OF THE COMMERCIAL DEVELOPMENT OF THE WORLD TO THE SCIENTIFIC DISCOVERIES OF THE NINETEENTH CENTURY.

Marcel Bichon—Revue Générale des Sciences.

IN all ages the growth of the commerce of a nation has been taken as the index of its prosperity, and at all times it has been the effort of progressive governments to foster and aid in commercial development. It was not until the beginning of the nineteenth century, however, that the influence of applied science upon manufactures and commerce began to be seriously felt, while at the close of that century engineering may well be claimed as the controlling factor in commercial progress. A general review of the evolution of the commerce of the world and its relations to the scientific discoveries of the nineteenth century is given in an interesting article by M. Marcel Bichon in a recent issue of the Revue Générale des Sciences, and the relation between commerce and engineering is there very clearly shown.

At the time of the Congress of Vienna, in 1815, upon the restoration of peace after the Napoleonic wars, the markets of the world were controlled by four nations: Great Britain, France, the Netherlands and Spain. These had all conducted their operations upon the antiquated methods which had prevailed from mediæval times, but from thence a new spirit began to prevail. In England the development of internal manufactures, following closely upon the introduction of steam power, the spinning frame, the power loom and the rolling mill, led to the adoption of free trade, admitting the food stuffs which the land was no longer able fully to supply, and permitting the march of industrial development to proceed unhampered. Although the rest of the world did not adopt the same system, yet throughout all manufacturing nations the influence of machinery began to be of controlling importance.

Following closely upon the development of power manufacturing came the locomotive in 1829; while preceding it, the work of Fulton led to the practical development of steam navigation as an element in the transformation of commerce. The Savannah crossed the Atlantic in 1819, while in 1825 the Enterprise made the first steam voyage to India. The engineer had established his grasp upon the commerce of the century by the time one-fourth of its years had passed. Screw propulsion soon followed the paddle wheel, and by the middle of the century great lines of steam navigation connected all parts of the world.

In the meantime the growth of railways had proceeded with increasing rapidity, and by the joint facilities thus given to commerce by the engineer the markets of the whole world were thrown open to the manufacturing nations of Europe.

With all this growth of commerce and manufacturing a new mode of communicating intelligence became necessary, and the task of providing it devolved upon the physicists. The result was the electric telegraph, originated in the United States by Morse, in England by Wheatstone, and developed in France by Bréguet. Hardly had overland telegraphy been practically introduced than submarine communication was attempted, and in 1851 the cable across the

Channel was laid and the telegraph line between Paris and London opened. Submarine cables then rapidly multiplied, and after the reverses of 1858 and 1865 transatlantic communication was finally opened in 1866, as a crowning result of the commercial energy of Cyrus W. Field and the scientific genius of Lord Kelvin, then William Thomson.

Transportation both by land and by water having thus been given to commerce by the engineer, as well as instantaneous communication overland and under sea, a new task was undertaken. The piercing of the isthmus of Suez was planned to bring the Orient 5,000 kilometres nearer to Europe, and in 1869 the Aigle passed from the Mediterranean to the Red Sea, and the engineer had opened a new route to commerce.

In the meantime these developments had met with a hearty response from the commercial world. Great engineering enterprises demand great financial resources, and the growth of banking facilities and aggregations of capital kept pace with the progress of industry. The discovery of gold in California and Australia came as stimulating additions to the wealth of the world. In 1846 the production of the precious metals is estimated at 310 millions of francs per year; in 1851 it had grown to 686 millions.

The greater proportion of all this development fell to England and France, and this momentous fact was revealed to the world by the series of international expositions which have done so much to aid in commercial development. In 1851 there were 17,000 exhibitors; 24,000 took part in Paris in 1855; at London, in 1862, there were 27,500 exhibitors; while at Paris in 1867 the number reached 42,217.

The growth of British commerce during the successive periods under consideration will show the extent to which the causes already cited affected it. In 1811 the external commerce of Great Britain was estimated at 1,400 millions of francs; from 1855 to 1859 it averaged 7,800 millions; and from 1865 to 1869 the average was 13 milliards. A parallel development took place in France. Thus from 1845 to 1859 the yearly average was 2,225 millions, while in 1865 to 1869 this had risen to 7,935 millions.

In all this progress Germany had taken little or no part, but after the events of 1870-71 the formation of the German Empire caused a new competitor to enter the field of commerce and of applied science. In spite of the great lead which had been attained by the older nations, Germany showed herself prompt and ready to profit by all the elements of commercial success which had been so effectively developed, and soon the mark "made in Germany" appeared in the markets of the world wherever manufactured goods penetrated.

Again a new and still more formidable candidate for commercial and manufacturing supremacy apeared upon the field. Before the Civil War the United States had been fully occupied in developing its own vast territory, but after the last traces of that conflict had disappeared a new order of things began. From 1877 to 1895 the great republic of the western world was actively building up her industrial resources, and then she vigorously entered upon a campaign of world commerce, which has given her a strong place among the great controlling nations.

Thus at the close of the nineteenth century the commercial control of the world stood transformed from the conditions which existed one hundred years before. Four great nations again held the commerce of the world between them, but the four were no longer the same, and Europe furnished but three of them. England, Germany, France and the United States—these constitute the great sources of the world's supply, followed at a distance by Belgium, Holland, Russia, Italy, and all the minor train.

The engineer of the past century has worked this transformation; the engineer of to-day is continuing the work with increased efficiency and vigor. It is more than probable that no great inventions or wonder-working discoveries will immediately appear; rather will the work take the form of improvement, extension, consolidation. Railway speeds and capacities will be increased, steamships will grow as harbours are provided to receive them. Methods and processes will be improved in character and enormously increased in efficiency; wastes will disappear from manufactures; labor will be handled and rewarded scientifically, effectively and adequately by the engineer.

If the past can ever be accepted as any

guide for the conduct of the future, the lesson of the nineteenth century may well be studied by the nations which are struggling for supremacy in the twentieth. The work of the engineer transformed the commerce, the politics, the finance, and the very life of the century which has just gone. What he may do for the present century depends wholly upon the opportunities which are given to him.

SCREW-PROPULSION FOR WARSHIPS.

A DISCUSSION OF THE IMPORTANCE OF THE SCREW PROPELLER AS A WEAPON OF OFFENSIVE WARFARE

Royal United Service Institution.

IN the merchant marine the screw propeller is regarded merely as a means for propelling the vessel from one place to another, but in the naval service it is often called upon to perform another function, that of driving the ship against the enemy, as in ramming or otherwise inflicting injury. Considering the propeller, therefore as a weapon of offensive warfare Fleet Engineer Quick presented a very interesting paper before a recent meeting of the Royal United Service Institution.

Examining first the possibilities in speed improvement by making proper improvements in the propellers, Mr. Quick cited the case of recent occurrence in the Royal Navy:

"The maximum speed of the four great cruisers of the Drake class was just over 23 knots with their original propellers. Without doubt the various makers of those propellers considered they were the very best propellers that could be designed for those vessels, and as those vessels attained something over the speed for which they were designed, the results appeared quite satisfactory. But the Admiralty very wisely ordered new blades of 30 per cent. greater area to be made for the Drake, with the result that the high speed of 24.11 knots was attained with practically the same indicated horse-power as had been required for 23.05 knots. If the original screws had been retained, they would have required 41,000 indicated horse-power to drive the ship at the speed of 24.11 knots. Please to consider the increase in weight and space, and cost of the boilers and engines of 30 per cent. greater power than the present boilers and engines, and also the increased consumption of fuel to provide that increased power. You would easily see that it would be almose impossible to cram such powerful engines and boilers into those ships, unless the store-rooms and magazines were abolished and the ship converted into a mere steaming machine.

"The enormous value of the Admiralty improvement of the Drake's screw must be apparent to all. But this improvement having been effected, the question arises: Is it possible to make a further improvement in the propellers of those ships so as to drive them at still higher speeds with the same horse-power? Experiments alone on one of those vessels can show exactly how much the maximum speed of those ships can be increased, but by some considerable changes in the present form of the screw propellers there is every probability of an increase of speed of at least one knot being attained with the same maximum horse-power—or, in other words, that the speed of the Drake class can be increased to 25 knots with the present boilers and engines, and with practically the same coal consumption as at present. To effect this, the proposed new screws would have to be more efficient than the large screws of the Drake to the extent of 4800 indicated horse-power. And as the large screws of the Drake gave a speed equivalent to an increase of 10,500 indicated horse-power over the original small screws, 25 knots is not an extravagant estimate for the speed of the Drake with propellers still further improved in design."

An important question in connection with possible improvements in screw propellers is found in the determination of the rate of increase in resistance with increased speed. If, as some maintain, the resistance increases as the fifth, seventh, or even tenth power of speed, there is indeed small hope for improvement. Such opinions, however, are based upon small experiments in tanks, and upon the rapid rise of in-

dicated power of ships at their higher speeds.

It is the opinion of Mr. Quick, based not only upon his own experiments but also upon the investigations of Mr. Robert Mansel, that it is not the resistance of the ship, that increases as the seventh to the tenth power of the speed at the highest speeds, but that it is the efficiency of the screw propellers which falls off at the higher speeds, and thus a very large part of the engine power is uselessly expended. It is far more probable that the resistance increases only as the cube of the speed, and that to attain higher speeds it should be the aim to reduce the rotational resistance of the propellers. In order to investigate the propeller losses at high rotative speeds Mr. Quick examines the case of a propeller of infinite pitch, in which all the energy is expended in overcoming rotational resistance, compared with a similar case for successive working pitch ratios showing very clearly that the rotational resistance increases much more rapidly than the propelling effect as the rotative speeds are increased.

"It has required many years of scientific research and hundreds of trials to bring the ordinary radial-surfaced screw, with its narrow-pointed blades, to its present condition of efficiency, and it is therefore to be hoped that a series of trials will be given to those new designs which appear to promise a large increase to the maximum speed of our warships and greater economy at all speeds, as modern conditions of great power and high speed of revolution demand changes in the dimensions, proportions, and form of the screw propellers to suit the new conditions.

"The adoption of four-bladed screws in lieu of three-bladed screws for our warships will be found of the greatest advantage in actual war. Accidents to propeller blades occur even during peace; and in war injuries to them will be much more frequent. When one blade of a three-bladed screw is broken off or seriously damaged, the remaining two blades will, if that screw be used for propelling, throw a very heavy stress on the shafting and cause excessive vibration, while the speed of the ship will be very small. But if one blade of a four-bladed screw be broken, and the engines be worked, there will be less strain on the shaft, less vibration, and a higher speed may be attained. This point is of importance to those who may have to command ships of fleets in battle.

"Twenty-eight years ago the writer advocated a combination of independent screw and hydraulic propellers; the latter being available for pumping vast quantities of water from the ship in case of ramming or injury by torpedoes. In consequence of the loss of the Victoria, and the recent ramming of the Prince George, it appears desirable that additional pumping power should be supplied to our fighting ships. That pumping power could be arranged to discharge the water astern, so as to be a considerable auxiliary propeller in case of injury to the screw engines and to the screw propellers. But the primary object of the large pumping power is to keep the ship afloat, for it is believed that in the naval battles of the future the ships will be so injured after an hour's plucky fighting that many ships will be sunk if they have only the present amount of pumping power; but that side which can keep the largest number of vessels afloat and capable of moving, if only at eight-knot speed, will be able to compel the enemy to surrender and thus to hold command of the sea against that particular foe."

It is interesting to note the revival of interest which is appearing in the subject of hydraulic propulsion, and reference may be made to the paper of Mr. Rankin Kennedy, reviewed elsewhere in this issue. In the course of the discussion upon his paper Mr. Quick gave some additional data upon the subject which are of general interest in the same connection:

"Great improvements have been made in the power and efficiency of pumping engines and pumps since the Waterwitch was built in 1866, and the Thornycroft hydraulic torpedo boat in 1883. At the present time Greenwood and Batley, of Leeds, are making the De Laval steam turbine engines and pumps combined up to 300 horse-power. These weigh about nine tons, and occupy a space of about 18 cubic yards only. A pair of 600 horse-power De Laval engines and pumps would weigh about 36 tons, and occupy 72 cubic yards. These engines of 1,200 total horse-power would be able to pump

about 17,000 tons of water per hour from a ship, *i. e.*, about as much water per hour as our biggest battleships displace. It is therefore evident that these pumps could cope successfully with an enormous amount of damage to the hull from ramming or torpedoes, which damage, with our existing appliances only, would certainly sink the ship.

"The water would be discharged in equal quantities astern on each side of the stern post, so that in the event of partial or total disablement of the screw propellers the jets would propel the ship ahead at a moderate speed, and in case of injury to the rudder the ship would be steered to a certain extent by the propelling jets. Of course, if the ship was uninjured, and the screw engines were disabled, the turbine pumps would take their suction direct from the sea. It is a matter for the consideration of naval commanding officers whether the proposed additional pumping, propelling, and steering power would be in actual battle worth a few hundred pounds in cash, the occupation of 72 cubic yards of space in the ship, and the substitution of 36 tons of machinery for 56 tons of coal."

GAS-POWER FOR CENTRAL STATIONS.

THE ADVANTAGES OF OPERATING ELECTRIC GENERATING STATIONS IN CONNECTION WITH GAS WORKS.

J. R. Bibbins—American Institute of Electrical Engineers.

SEVERAL years ago the late Sir Frederick Bramwell made the prediction that by the year 1931 the steam engine would be of interest only as a relic of a past age, having been entirely superseded by the various forms of internal-combustion motor. When it is remembered that he said this at the meeting of the British Association, in 1881, when the gas engine was built in small sizes only, and considered by steam-engine designers as little more than a toy, the wisdom of the prophecy will be more apparent. To-day, with engines of 1,000 horse power and more in daily use, and with interest and activity in the subject daily growing, it takes no especial foresight to see that, for many purposes at least, the internal combustion motor is the coming engine. An interesting contribution to the subject is the paper recently presented before the American Institute of Electrical Engineers by Mr. J. R. Bibbins, discussing the advantages of operating electric stations in connection with gas works, the electric generators being driven by gas engines, and the gas works supplying the fuel.

It will be remembered that when electric lighting was first introduced it was supposed to be a great rival to existing gas companies and gas stocks took a tumble. Experience has shown, however, that there is room for both, and in many places the gas and electric stations are operated by the same company. Mr. Bibbins gives data from a number of installations in which this idea is carried still further, the electric station being made a partial customer for the gas plant, to the extent of using gas as the source of power from which to generate the electric current. The general proposition which he maintains is that present gas-power machinery is suitable for central-station service; that the economy is far better than a steam plant; and that the most effective way for a gas works to meet electric competition is to install a gas-power electric-generating station, and become its own largest customer, selling both gas and electricity at competitive rates.

Probably one of the principal reasons for hesitation of the engineer in considering gas power for an electric station lies in the question of irregularity of operation, but according to the investigations of Mr. Bibbins, the records in existing plants for continuous running compare favorably with those of steam-power plants.

The majority of the plants are operated from 18 to 22 hours per day, and in some instances the engines are run continually from Monday morning to Saturday night without stopping.

"In cost, the gas-engine equipment is quite comparable with that of a steam plant. The engine itself costs more than a steam-engine of corresponding size, on ac-

count of the increase in metal required by the higher pressures dealt with. With the cost of condensing machinery charged to the steam-engine, however, this disparity is much reduced. With natural or illuminating-gas supply available, the equipment-cost would fall considerably below that of a steam equipment of boilers, engines, condensers, heaters, pumps, etc. In the case of a producer-gas plant installed to supply the gas-engines, the cost of the respective equipments, each of 1,000-h. p. is at a parity, although depending somewhat upon the storage capacity provided."

The economy of the gas engine in fuel is well understood, even small gas engines giving a superior thermal efficiency than is attainable with the largest steam engines. The fuel cost of a horse-power naturally depends to a certain degree upon the nature and cost of the fuel, but in general the fuel consumption should not exceed 1 pound per brake horse-power-hour.

Apart from the immediate fuel economy, however, the gas engine possesses other advantages which conduce to general station economy. The efficiency under light load is higher than that of a steam engine of corresponding size. The cost of operation and maintenance is low, largely because of the simplification of the equipment and the small number of auxiliaries. The engine can be started much more quickly than is possible with a steam plant, and the absence of high pressures except in the engine cylinder removes all danger of explosion. The ability to store power in the form of gas in a holder is a valuable feature of a gas power plant, the cost of power storage in this way being far less than when electric storage batteries are used.

"An important source of economy in gas plants is the fact that as soon as an engine is shut down all heat-losses cease. Also, during operation no heat is lost by the gas in transit from the producer, and the plant is not hampered by inefficient auxiliaries such as steam-pumps, condensers, return-traps, etc., all of which largely increase the general complexity of the system. Steam-pipe and cylinder-condensation losses, radiation, leakage in piping, and fuel-loss in banking fires, have no parallel in the gas plant. The only auxiliaries required are the igniter-generators, and air-compressors. The former are negligible as affecting the economy of the station, and the latter operate at full capacity at regular intervals. In cases where artesian wells supply jacket-water, a pump is of course, required, preferably operated by a motor or small gas-engine to which the air compressor may also be belted.

"In quick starting, the gas-engine fulfils every requirement. The 280-h. p. pumping units of the Philadelphia high-pressure fire system have been repeatedly started cold, brought up to speed and the pumps loaded to the required pressure (300 lb. per sq. in.) within a period of 40 seconds from the starting signal. In another plant, employing 133-cycle high-speed generators, the units are regularly started in two minutes, and this may be reduced to one minute in case of necessity.

"A number of plants make use of hot jacket-water for heating offices and building, ordinary cast-iron or coil-pipe-radiators being used for this purpose. One station partly supplies a municipal heating system resembling the Yaryan, thereby deriving direct revenue from a waste product. Part of the return-water is sent again through the jackets, the temperature being lowered to the proper degree by adding fresh water from the station supply-main. Another station returns hot jacket-water to a large cistern where it partially cools and is again pumped through the jackets emerging at a temperature of 200 degrees F. before being discharged into the sewer. As return water from a heating system is also discharged into this will, a small amount of cold water from artesian well or city water system is added from time to time, to reduce the general temperature of the circulating system. In another plant, the jacket-water is utilized in winter for warming the water in the gas holders to prevent freezing. This was formerly done by using live steam from a boiler used in making water-gas."

Various kinds of fuel gas may be used in internal-combustion engines, and the relative economy of different gases is sometimes considered as depending upon the calorific value. As a matter of fact the different gases require different proportions of air to be used to make the proper explosive mixture, and the ratings are better

made by comparing the calorific value per cubic foot of the actual mixture delivered into the cylinder. Under such conditions the value of various gases is nearly uniform, as will be seen by the accompanying table, the only ones falling much below the average being producer and blast-furnace gases.

	Approximate B. T. U. per cu. ft.	
	Gas	Mixture
1. Natural-Gas	1000	91.0
2. Coal-Gas	650	91.7
3. Water-Gas	300	88.0
4. Carburetted Water-Gas	600	92.0
5. Producer-Gas	120 to 145	60 to 68
6. Coke-oven gas.....	600	90.0
7. Blast-furnace gas....	90	53.0

"The power to be developed by an engine of given proportions does not therefore vary within appreciable limits, except on producer-gas and blast-furnace gases, when larger engines are required, or larger cylinders on the same engine frames. The rate of combustion is, however, less rapid with these than with other gases, due to the large amount of inert gases such as nitrogen and carbonic acid present in the mixture. The compression may also be carried much higher without risk of pre-ignition or "back-firing," thus increasing the efficiency of the cycle. With water-gas the high percentage of hydrogen occasions quicker combustion and higher flame temperatures with so considerable a tendency to pre-ignition and back-firing that this gas is not well adapted to gas-engine work.

"In water-gas plants a great saving may be made and the gas rendered much more suitable for the operation of gas-engines by providing additional holders for the air or blast-gas made during the period when the producers are under blast. This gas is equivalent in calorific value to blast-furnace gas—90 B.T.U.—and is generally allowed to go to waste. It may however be used to great advantage for power purposes, either alone or mixed with a proportion of water-gas which it renders less snappy and thereby better suited for use in gas engines. In fact, by this means a gas is obtained similar in many respects to the producer-gases made by operating a producer continuously with combined steam- and air-blasts.

"Leaving out of consideration the by-product, or waste coke-oven and blast-furnace gases, as occupying a field of power development somewhat foreign to the subject in hand, producer-gas offers at present the greatest possibilities in the field of power for use in manufacturing centers. This is due to its comparative cheapness. simplicity of installation and general efficiency when gas for power purposes is alone considered."

Mr. Bibbins includes in his paper tabulated data and results of a number of gas-power stations and has reduced the results of his investigations to curves for which the reader must be referred to the original paper. The conclusions are so generally favorable to the commercial advantages of the combination of gas works and electric generating stations that the arrangement must appeal with much force to the managers of existing gas plants who are seeking to extend their business, and the whole subject is an excellent example of the manner in which new and improved methods and systems act, not as injurious rivals to older plants, but as reasons for extended scope and efficiency.

THE TEMPERATURE OF FLAMES.

RECENT DETERMINATIONS OF THE TEMPERATURES OF VARIOUS FLAMES BY THE USE OF THE SPECTROSCOPE.

Ch. Féry—Académie Des Sciences.

THE determination of the actual temperature of a given flame is a matter which presents certain difficulties, and hence the presentation of a paper before the French Academy upon an accurate method, together with the results of a number of experiments, demands notice. M. Ch. Féry, whose paper is given in a recent issue of *Comptes Rendus*, discusses the usual methods of temperature determination and shows the reasons for variation.

The ordinary method for measuring the

temperature of a flame is to insert into the flame a small solid body, which body it is assumed, must acquire the temperature of the flame itself. If this body is the junction of a thermo-electric couple, it may itself be used as the means for measuring the required temperature. Results obtained by this method, however, are very discordant, showing the existence of various defects in the method, even after all apparent corrections have been made. Among the sources of error we may include the losses by radiation, of which the corrections are uncertain, also the emissive power of the metal, which, at high temperatures is imperfectly known, especially since it may be modified by the action of the gases upon the physical constitution of the surface. It is certainly known that carboniferous flames affect the purity of platinum, and change its conductivity, an important matter in connection with the use of thermo-electric couples.

The presence of a foreign body may alter the temperature for certain other reasons, among which may be noted the effect upon the velocity of the gaseous current. The burning gas possesses a certain degree of viscosity, and the presence of a solid body, however small, alters the velocity of the gaseous layers which surround it. Since the specific heat of a gas is very small compared with that of a solid, and because gases are much poorer conductors of heat than solids, certain phenomena observed in this connection will be seen to have an influence upon the determination of temperatures. Thus, a platinum wire of 0.02 mm. diameter in readily fused in the flame of an ordinary Bunsen burner, but the resulting bead remains unaltered and solid in the same flame, although the temperature is unchanged. This shows that the retardation of the flow of the gases caused by the bead prevents the temperature from exceeding 1,780° C., so that a platinum thermo-electric couple is unequal to the determination of the temperature of the flame of a Bunsen burner.

The method employed by M. Féry avoids the introduction of any solid substance whatever in the flame, being based upon an entirely different principle. This principle is that of the reversal of a given line of the spectrum by means of the rays emitted by a solid body raised to a convenient temperature. At the moment when the line of the spectrum, in passing from light to darkness, disappears, the temperature of the solid corresponds to the temperature of the flame.

In the practical experiments conducted by M. Féry the solid substance selected was the filament of an incandescent electric lamp, the temperature of which could be readily determined by the use of the absorption pyrometer, the rays emitted by the solid incandescent carbon traversing the flame to be examined, this latter containing the vapor of sodium. By use of a lens an image of the filament was obtained in the slit of the spectroscope in such a manner that the continuous spectrum given by the incandescent carbon was seen traversed by the D-line, so that it could be reversed, and consequently made to disappear by any of the flames under investigation.

M. Féry gives a number of determinations of flame temperatures, and as these represent the latest accurate measurements of values of practical use we give some of the more important ones. Thus for the Bunsen burner, burning ordinary illuminating gas, the mean of 8 determinations, the burner having a full supply of air, gave a temperature of 1,871 degrees Centigrade, while with a half supply of air the temperature fell to 1,812 degrees, and the total suppression of the air supply brought down to 1,712 degrees. The acetylene flame gave a temperature of 2,584 degrees, and a free alcohol flame showed 1,705 degrees. By taking a Denayrouze burner, intended to be used with an incandescent mantle, and using the vapor of alcohol, a temperature of 1,812 degrees was attained, or nearly the same as with the Bunsen burner, showing that in this case the mantle should give about the same amount of light as with the corresponding incandescent gas burner. The same lamp, using a mixture of alcohol carburetted with 50 per cent. of benzine, gave a temperature of 2,053 degrees, this being decidedly higher than the 1,900 degrees obtained with a flame of hydrogen burning freely in air.

With the gas blowpipe, using oxygen and illuminating gas, a temperature of 2,200 degrees was reached, while the oxy-hydrogen

blowpipe, burning the gases in the proportion required to form water, attained a temperature of 2,420 degrees. The oxy-acetylene blowpipe, reference to which has already been made in these columns, gives a still higher temperature, estimated to be about 4,000 degrees C., but this has as yet not been verified by the method of M. Féry.

The importance of these scientific determinations of flame temperatures must be admitted, especially as they show the influence of the presence of solid bodies in cooling flames locally. Not only does this cooling affect temperature determinations by the earlier methods, but the same action exists when flames are used to heat solid bodies. For this reason it is important that gas furnaces and similar appliances should be arranged with heat absorbing substances, so disposed as to store up the heat and provide a sufficient mass of incandescent material to offset the absorption of the cold material inserted in the flame. Experience has shown the advantages of such constructions to practical work, and the laboratory tests of M. Féry confirm the soundness of the method. Thus a simple block of fire brick, suspended over a gas flame absorbs heat which it again radiates downward upon a solid substance placed in the flame, and while such a simple addition cannot raise the actual temperature it does prevent the lowering of the heat which would otherwise occur. Similar arrangements are made in many practical cases, and with the increasing of the clean and convenient gas furnace this feature will doubtless be given scientific study and improvement. In the meantime the determinations of M. Féry will doubtless stand as the most accurate and reliable measurements of flame temperatures which have yet been made.

SMOKE PREVENTION.

PRACTICAL METHODS IN USE FOR PREVENTING THE FORMATION OF SMOKE IN STEAM-BOILER FURNACES.

W. H. Bryan—Purdue University.

IN an address recently delivered before the students of Purdue University, Mr. W. H. Bryan discussed the methods in practical use in the West and Southwest for the prevention of smoke from boiler furnaces, and in view of the extended experience which he has had in this important subject some abstract of his remarks are here given.

Smoke is mainly due to the presence of volatile matter in the coal, and as the Western fuels are rich in volatile matter the smoke problem has assumed especial importance in cities in which these coals are used.

"When a fuel rich in volatile matter is charged into a furnace, the volatile matter is first set free as a gas, principally in the shape of hydrocarbons. Part of these are of the olefiant series, and are dissociated at a red heat. Part of the carbon is set free, and if unconsumed, it passes off as smoke. It is possible to burn this free carbon, if sufficient oxygen is present, and the temperature is high. Failing in either of these conditions, there will be smoke.

"The free carbon in the densest smoke is very small—from one-sixth to one-half of 1 per cent. by weight. It has, however, great coloring power. You may stamp as false all claims of fuel saving due to consuming the smoke. The best furnaces, however, do make savings in fuel, not because they burn the smoke, but because improved construction and better engineering details bring about more favorable furnace conditions. The saving is often more than sufficient to pay a good interest on their cost, besides repairs and maintenance."

Mr. Bryan gives three methods of preventing smoke. The first of these is the heroic one of shutting down the smoke-producing establishments. In many instances, however, this has been the best of all methods, because it has compelled the offenders to use electric power derived from some central station. An excellent example of the relief by this drastic method was seen in New York when the smoke-producing locomotives were removed from the elevated railroad system, the fuel-combustion being concentrated at the power houses

where it could be taken care of. Ultimately this will be the true solution, the burning of smoke-producing fuels being altogether prohibited within city limits and proper methods of prevention required at the generating stations where the current is produced for municipal use.

The next best plan is the use of smokeless fuels. This cannot be expected to be generally adopted so long as the cost of such fuels continues to be far higher than those which ordinarily produce smoke. Anthracite, coke, or oil may be burned without producing smoke, but in most markets the smokeless fuels are out of reach in cost. Possibly the use of oil in motors of high economy, such as the Diesel, may help to solve the problem, but when burned under boilers, oil costs too much to compete with the cheaper coals.

Passing to the smoke producing fuels, Mr. Bryan describes the various methods which have been employed to promote smokeless combustion. When a boiler is ample in size for its work, so that it may be fired slowly and quietly the matter is a comparatively simple one.

"A good ordinary boiler furnace without a special device can be so handled as to greatly reduce the smoke, providing, of course, it is not overworked. It is not necessary, therefore, to buy a patent furnace. Nor will the installation of improved apparatus of itself control the smoke. A deep furnace, high bridge wall, ample grate surface and good draft are essential to a good smoke record. Such a furnace, skilfully fired, will make no serious smoke when working up to, say, two-thirds of its rated capacity. By skilful firing is meant the charging of alternate doors with small and uniform quantities of fuel, particularly if the coking system of firing is used. The firing of consecutive doors, at long intervals, with large quantities of fuel, and by the sprinkling method, is responsible for a very large proportion of our smoke. If the furnace, however, is not well designed, or is overworked, no amount of skill or care will keep the smoke within bounds. In such cases resort must be had to special apparatus."

Among the successful processes Mr. Bryan names five which are to be considered. The first of these is the use of steam jets, either below or above the grate. These naturally act to produce induced currents of air and to drive these currents into the fire, thus providing an excess of oxygen and aiding in the necessary mixing of the air and gases. Properly arranged they will reduce the smoke, but they are not usually economical of fuel, and to give the best results they should be given some attention.

A better system, and a far older one, dating back to the time of Watt, is the use of coking furnaces, or their modifications in the form of fire brick arches. These are based upon the principle of keeping the fuel well away from the chilling action of the boiler surfaces and completing the combustion at a high temperature in the presence of the proper quantity of air. They require additional space and should be given intelligent attention, two requirements which it appears difficult to obtain.

Another appliance is the down-draft furnace, which in many instances has given very good results. Two grates are used, the upper one forming part of the circulating system of the boiler, the grate being made of water-tubes to resist the high temperature. The second grate is beneath and the gases from the two grates meet between them, where thorough combustion is effected. Mr. Bryan gives as the principal objection to this type its high first cost and its connection as a part of the circulating system of the boiler.

An important class is that of automatic stokers, in which Mr. Bryan includes chain grates and underfeed devices.

"These have come into extensive use, particularly in large modern plants. While they are built in many forms, they all operate on the same principle—that of feeding the coal automatically to the grates in continuous and regular amounts. Most of them are designed for the use of the finer grades of coal, such as nut, pea or slack. In many localities there is a surplus of this fuel, and its cost is low, but the increased demand is raising the price and reducing the supply. Many recent stoker plants are provided with crushers to permit the use of the larger sizes of coal when necessary. When accompanied by coal handling and storage plants, the automatic stoker reduces the labor required in the fireroom, and this arrangement has been adopted in

many large modern plants. The ability of the stoker to maintain practically uniform steam pressure, and the fact that the air supply is nearer theoretical requirements, are features which have contributed largely to its success.

"The objections to automatic stokers are: First, their great cost; second, the complication of parts and the necessity of repairs; third, the steam required to operate them. Under proper conditions there is a material saving both in fuel and labor. That the objections named are not serious is shown by the fact that their use is constantly increasing. The fuel to be burned should have expert study, however, before a device of this kind is selected, as they are not equally well adapted to all fuels. Some do not respond to fluctuating loads, and to overwork."

Powdered fuels have also been considered as enabling complete and smokeless combustion to be maintained, but down to the present time the cost of grinding to the fine degree necessary for the best results has been prohibitory.

A plan not mentioned by Mr. Bryan, but which may yet be found to meet all requirements is the general employment of gas fuel. The leanest and poorest of coals may be used under proper conditions for the production of fuel gas, and when employed in connection with internal-combustion engines a high efficiency can be attained together with the entire abolition of boiler and furnace. The ideal system would include gas-power electric generating stations, delivering electric power into all parts of a city, and wholly replacing smoke producing furnaces of any kind.

THE NORTHERNMOST RAILWAY OF THE EARTH.

OPENING OF RAILWAY COMMUNICATION BETWEEN THE GREAT IRON ORE DEPOSITS OF LAPLAND AND THE SEA.

H. Claus—Glasers Annalen.

SEVERAL years ago the importance and magnitude of the deposits of iron ore in the northern part of Sweden and Norway were described in the pages of this magazine, and the interesting paper by Mr. Louis in the issue of July, 1899, attracted attention. Since that time the construction of a railway to enable the deposits to be worked to advantage has been completed, and in the summer of 1903 the road connecting the Gellivara district with the port of Narvik, on the Ofoten Fiord, was formally opened by King Oscar, with appropriate ceremonies. In a recent issue of *Glasers Annalen für Gewerbe und Bauwesen*, an account of the of the importance of this railway is given by Herr H. Claus, from which some abstract is here made.

As Herr Claus states, this railway is the northermost line in the world, the highest point, three kilometres from Narvik, attaining a northerly latitude of 68° 27′, and thus lying above the Arctic Circle. The White Pass railroad in Alaska reaches a latitude of about 60° N. The present road cuts entirely across Lapland, connecting the Baltic with the Atlantic ocean, and passing through the great iron-ore deposits of Gellivara, Kürunavara and Luossovara. These ores are especially adapted for use with the basic process, containing an average of 65 per cent. of iron, and from 1 to 2 per cent. of phosphorous. Deposits also exist containing as high as 68 per cent. of iron, and sufficiently low in phosphorous to be suitable for the acid Bessemer process. The total area of the deposits covers about 425,000 square metres and the quantity of ore available above the level of lake Luossajärvi is estimated by the Swedish State Geologist, Professor Lundbohm, as from 233 to 292 million metric tons. If the excavations are continued below the level of the lake the amount of ore which can be taken out is estimated at 500 to 750 million tons, and more.

Various plans have been made in past years to provide railway access to these important ore deposits, and as long ago as 1870 an English company obtained certain concessions. Later these plans were undertaken by a Swedish and Norwegian private company, but the work met with various difficulties and only the Swedish portion

from Lulea to Gellivara was completed. Finally, owing to the international character of the work, it was decided that it should be completed and controlled by the government. The arrangements were concluded in 1898 and the work, as has already been stated, was brought to a successful conclusion last summer.

The terminal of the railway on the Atlantic is at an excellent harbor at Narvik, this being 174 kilometres distant from the nearest ore beds at Kürunavara and 286 kilometres from Gellivara. The total distance from Navik, on Ofoten Fiord to Lulea on the Gulf of Bothmia, is 483 kilometres, or 300 miles.

Apart from the importance of the opening to commerce of these important deposits of iron ore the connection of the northern section of Norway and Sweden to the railway systems of Europe is a matter for comment. At Boden, not far from Lulea, the new railway intersects the Swedish railway system, extending southward on the one hand to Stockholm and the rest of the peninsula, and on the other to St. Petersburg and the whole network of Russian railways. From Navik to St. Petersburg, a distance of 1,800 kilometres, there is now continuous railway communication, and from St. Petersburg on over the line of the Siberian Railway to Vladivostok. By the completion of this railway the line across Europe and Asia connecting by rail the Atlantic and the Pacific oceans is achieved, the distance being 11,900 kilometres, or about 7,400 miles, and at the average speed of 30 kilometres per hour the journey from ocean to ocean may be made in about 16 days.

THE PREPARATION OF BOILER FEED WATER.

AN INQUIRY INTO THE WORKING OF VARIOUS PROCESSES FOR SOFTENING WATER FOR USE IN STEAM BOILERS.

Institution of Mechanical Engineers.

So long as steam boilers are in use, so long will efforts be made to prevent the formation of scale or to get rid of it after it has been formed. Many plans include the putting of things into boilers to keep the impurities from doing any harm; while still other, and more reasonable plans have been advocated to prevent the injurious matter from getting into the boiler at all. This whole question of the preparation of boiler feed water forms the subject of an important paper presented before the Institution of Mechanical Engineers by Mr. C. E. Stromeyer and Mr. W. B. Baron, which we take this occasion to review.

In the first place an important distinction is made between the action of scale upon the heat efficiency of a boiler and upon its durability.

"It has frequently been stated that scale seriously reduces the heat efficiency of boilers, and experiments have been made which seem to prove this assertion, but it will be found that they have been carried out on wrong lines, and they only prove that scale very seriously interferes with the transmission of heat if the heat source, usually a flame, is of equal temperature over the whole surface. In a boiler the temperatures vary from 3,000° to 4,000° F. at the furnace, down to 500° to 1,000° F., where the gases leave the boiler. Let us take a simple case, assuming for convenience of calculation that the heat transmission from flame to boiler-plate is proportional to the difference of temperatures. Let the ratio of air to fuel be as 20 to 1; let the air temperature be 80° F., then the flame-temperature will be 3,000° F. If the steam-temperature is 380° F., the maximum temperature of the furnace-plates will, in the above example, be only 20° F. higher than that of the steam, viz., 400° F. Now let us assume that the heating surface is covered with scale ⅛ inch thick; then, if the same quantity of heat were transmitted through the coated furnace-plates as through the clean ones, the temperature difference between one side of the scale and the fire side of the furnace would be 350° F., and the temperature of the plate would be 730° F. It is, however, clear that as the boiler-plate is hotter than in the first example, less heat will be transmitted to it and the temperature gradient in the scale will be less steep. Naturally also the flame will not get cooled so rapidly, and

its temperature, as it reaches the next portion of heating-surface, will be higher than before."

Tabulating the results of an investigation into the temperature distribution in a boiler, assuming first entire freedom from scale, and secondly, a layer of scale ⅛ inch thick, it is shown that even for fairly high differences of temperature, such as occur for the portions in which the ratio is ¼ square foot of heating surface per pound of fuel per hour the reduction in the heat transmission is only 11.6 per cent., while by the time the gases reach the end of a lightly worked boiler, where the ratio is 4 square feet per pound of fuel per hour, the total reduction in transmission is only 2.5 per cent. When boilers are subjected to hard firing or forced draft the difference is of course greater.

The great injury caused by scale is that of the effects of overheating upon the plates. Even ⅛ inch of wet scale may raise the temperature of the furnace plates by nearly 300° F.

"Scale is thus a serious danger, and, as is well known, has frequently caused accidents. It will be noticed that in clean boilers the temperature of the furnace-plate is nearly the same as that of the water, whereas in the scaly boiler the excess temperature is about one-tenth of that of the flame. If, therefore, in the first case we open the furnace door and admit cold air, the excess temperature of the furnace-plate can at most be reduced 20° F., causing a contraction of only 1-90 inch in 8 feet, whereas cold air admitted to the furnace of the scaly boiler will effect a rapid reduction of about 311° F. accompanied by a contraction of 1-6 inch in 8 feet, which is a very serious matter. In fact, in a rigid structure these two strains would be accompanied by stresses of 1:5 and 22 tons respectively. Boilers are elastic, but a large fraction of these stresses certainly make their appearance every time that a furnace door is opened, say once every half-hour, or 6,000 times a year. No wonder, therefore, that in high-pressure boilers, which are necessarily more rigid than low-pressure ones, this constant straining leads to grooving at the furnace flanges. With scale ¼ inch thick the stresses would be nearly doubled.

"We thus see that scale does not materially reduce the efficiency of a boiler, but it seriously increases its wear and tear, whereby its life is considerably reduced. It also endangers the safety of boilers. The same remarks apply to coatings of grease due to feeding the boiler with water containing condensed steam from the engine. It is, therefore, desirable to remove all scale-forming impurities from the feed-water. These impurities are suspended matter, carbonate of lime, sulphate of lime, magnesium salts and grease. One has also to be on one's guard against introducing large quantities of soluble salts, as these concentrate when the water evaporates, until thick scales of crystals are formed."

Mr. Stromeyer examines the behaviour of the various impurities in feed water at length, and his paper forms a valuable essay upon this important subject. The chief cause of temporary hardness is the presence of carbonate of lime, which, being converted into bicarbonate of lime, is readily soluble in cold water, and is of very general occurrence. So-called permanent hardness is caused by sulphate of lime, while the salts of magnesia are also objectionable. The presence of grease in a boiler is more injurious than any scale, and much of the trouble from overheated plates is due to the presence of a film of grease, carried into the boiler with the feed water from the condensers. It is impossible here to go into the whole subject of feed water purification, but a brief summary is here given:

"Carbonate of lime forms hard scale in economisers and a soft mud in boilers, unless sulphate of lime is present, when it also is cemented into a scale. Carbonate of lime can be removed by boiling or by adding enough caustic lime or caustic soda to combine with the free and half-bound carbonic acid which hold it in solution.

"Sulphate of lime forms no scale in economiser pipes, but it forms a very hard scale in boilers and also cements the carbonate of lime deposits. Its deposition in boilers is due to slow concentration of the water, and it is, therefore, desirable to remove the salt entirely. This can always be done by adding carbonate of soda which converts it into carbonate of lime.

"Carbonate of magnesia generally behaves like carbonate of lime, except that it is slightly more soluble.

"The other salts of magnesia are very sol-

uble. They seem to cause corrosion and should be removed. This can be done by treating them like the sulphate of lime by adding carbonate of soda.

"Grease should, if possible, be kept out of a boiler. Neither separators nor filters will remove it entirely from feed-waters, but this can be done by mixing them with impure waters and treating them in water softeners."

The theory of water softening has been well known for a long time, but there are various practical difficulties which only appear in the actual working of the apparatus. Thus carbonate of lime, when precipitated by proper chemicals, is in a colloidal condition, like thin starch, and passes readily through the best chemical filters. The fineness of the precipitate renders it very slow in settling, especially when cold, so that very large tanks and much time are required. By carrying out the softening operation hot the separation is more readily effected, and smaller tanks may be used. Magnesia precipitates are also very difficult to manage, because of their gelatinous nature, and heat is usually found necessary in their treatment.

Another important practical matter in water treatment is that of properly apportioning the chemicals. The class of labour to which this work is often intrusted is found lacking in judgment; the apparatus should provide some mechanical means of regulating the amount of material added and its proper admixture. In many cases too little lime is added, and an excess of soda is applied, while when heat is employed it is not given sufficient time to effect the best results. No process can be expected to give entire satisfaction without a certain amount of skilled supervision, but the benefits to be gained by proper treatment are well worth the cost of such oversight.

The paper is accompanied with illustrated description of a number of the best devices for water softening, and forms a valuable contribution to the literature of the subject.

STROBOGRAPHIC METHODS OF OBSERVATION.

THE SLOW REGISTRATION AND INVESTIGATION OF PHENOMENA OF HIGH RAPIDITY OF OCCURRENCE.

E. Hospitalier—Institution of Electrical Engineers.

NEARLY two years ago we reviewed in these columns a paper presented before the French Society of Civil Engineers upon modern methods and devices for observing rapidly varying periodical occurrences. We now have a later paper upon a similar subject, presented before the Institution of Electrical Engineers, in which M. Hospitalier, to whom the original paper was due, discusses especially the progress which has been made in strobographic methods for examining moving objects. The paper is an excellent example of the manner in which indirect methods may often be found more useful than direct methods of apparently similar character.

"Indirect observation, based upon stroboscopic principles, is effected by reproducing the phenomenon with a much longer period, obtaining the record of the whole of its phases by taking them successively from a large number of periods. The period of oscillation peculiar to the apparatus may, in this case, be very long as compared with that of the phenomenon observed, provided that the duration of the total number of periods from which the different phases are collected is itself very great relatively to that of the oscillation peculiar to the recording instrument.

"Notwithstanding the elegance of the direct methods, and the results which have already been attained with instruments based upon them, the author is of opinion that the industrial future is reserved to the indirect methods, which have a wider field of application, and which permit of the direct recording of the phenomenon to be studied upon a strip of paper, in a way that is not possible with the direct methods, in which recourse is always had to photography. In order to understand the principles of the stroboscope, as applied to the observation and recording of periodic and rapidly-varying phenomena, the most simple of all the periodic movements may be considered—namely, that of uniform rotation.

At the end of every revolution the rotating system attains the same relative position that is occupied one complete turn earlier. Suppose, now, that the system is illuminated for a very brief instant once in each revolution at the moment at which it passes a certain position, which is regarded as the initial position. The rotating system will then appear at rest. If, now, the periodic illumination be slightly retarded, so that the successive flashes follow one another at an interval of time a little longer than the period of the revolution itself, the system will be illuminated in its various phases in turn, and will appear to revolve slowly in the sense of its actual rotation. If, on the contrary, the flashes follow at shorter intervals, the system will appear to be turning in a sense inverse to that of its real rotation, since at every revolution it will be illuminated an instant before it attains the same position as on the preceding revolution. In this way the apparent velocity of rotation will have been reduced in a proportion which depends only on the acceleration or retardation of the successive illuminations of the system.

"The simplest means of obtaining these successive flashes consists in using a disc pierced with a slit as a shutter in front of a projector. The same result may be obtained by means of the sparks caused by interrupting the current through an inductance, or with alternate-current arcs, &c., but the sharpest effects are obtained with the revolving stroboscopic disc.

"In order to obtain a variable difference in the periods or slip, it is possible to use an electric motor of which the speed is capable of variation—or a synchronous motor if the system is driven by a synchronous machine—which determines the measure of the slip, or a train of wheels as in the ondograph, or (the most rational of all) a differential gearing of which one of the axes is controlled by the system to be studied, whilst the other actuates the stroboscopic disc and the crown containing the intermediate wheels between them receives from an outside source a more or less rapid movement of rotation which defines the slip. This disposition offers the great advantage of allowing the phenomenon to be apparently stopped in any specially interesting position."

All such methods, in which the phenomena are simply observed by the eye as they occur, are of value in connection with the study of any special apparatus, being really similar in principle and operation to the well-known zoetrope. It is most desirable, however, that phenomena under observation should be recorded automatically and independently of the observer, in order that the personal equation may be wholly eliminated. Such instruments are called strobographs, this term being broadly applied to all forms of apparatus employed to record phenomena, whether rapidly or slowly variable, if they utilise the principle of the stroboscope.

H. Hospitalier describes a variety of instruments which come under this definition of a strobograph, the principal being the ondograph, or wave recorder, used for registering directly such electrical phenomena as the curves of variable currents, differences of potential, power, etc. The detailed construction of the apparatus is fully described in the paper, the principle being the use of a rotating drum and a revolving commutator, both being driven by a synchronous motor, the relative rotative speed-relation being capable of variation through a train of gearing. By the use of a suitable recording measuring apparatus, varying in character according to the nature of the phenomena under observation, all the conditions obtaining in the visual stroboscope are reproduced mechanically.

The applications of the ondograph are numerous, and M. Hospitalier gives examples of some of its records. Thus it is understood that the curve produced by an alternator is in principle a sine curve, as free as possible from the higher harmonics, but the records actually obtained show that this is far from the case in practice.

Some of the curves obtained in the instrument show the influence of the shape of the pole pieces, which introduce the third and fifth harmonics, while others exhibit the effects of the teeth. A careful study of the curves makes it possible so to alter either the pole-pieces or the number or shape of the teeth that the objectionable distortions are greatly reduced, and hence the instrument possesses an immediate practical value. Other important applications

are found in the investigation of the reaction of the alternating current on the excitation, and in a study of the variation in the difference of potential between the terminals of a rotary converter. Various interesting applications, of which M. Hospitalier gives the recorded diagrams, are seen in the variations occurring in the primary current of a transformer for given variations in the secondary and again in the study of the action of the electrolytic rectifier. Many other applications of the instrument are apparent, such as the study of the Wehnelt interrupter, the continuous-current arc, rectifiers, the oscillatory charge and discharge of condensers, polyphase currents, the simultaneous record of potential differences, current, and power in an alternating circuit, etc.

A large portion of the improvement in the efficiency of the steam engine has been due to the study of the operation of existing machines by the aid of the indicator, and it is certain that many improvements would have been long delayed had not some such mechanical method of recording internal action been employed. The employment of strobographic methods permits similar investigations to be made of electrical action in a manner not otherwise possible, and many improvements in structural and operative details should follow their use.

MODERN NAVAL BOILERS.

A CRITICAL COMPARISON OF THE RESPECTIVE MERITS OF WATER TUBE AND CYLINDRICAL BOILERS FOR NAVAL USE.

W. L. Cathcart—American Society of Naval Engineers.

ALTHOUGH the relative merits of the water-tube and cylindrical types of boilers for naval use have been and still are subjects of active discussion the progress which has been made in the installation of the former kind has been marked in the last year or two. A very excellent review of the present situation appears in the Journal of the American Society of Naval Engineers, by Professor W. L. Cathcart, and in view of the present importance of the subject some abstract of the paper is appropriate.

Mr. Cathcart reviews rapidly the entrance of the water-tube boiler into the marine service, referring to the early installations of the Belleville boiler in the French navy as long ago as 1856, and the successful career of the Martin boiler in the American navy. The advent of the mutiple-expansion engine and the continual increase in steam pressures, however, led to the general use of the cylindrical, or Scotch boiler, both in the merchant marine and in the naval service, and it was not until 1885 that any serious attempt was made in England to use any other type. The first installations were of the small-tube type in vessels of moderate size; Thornycroft boilers being fitted to torpedo boats and destroyers. The extending use of the improved Belleville boiler in France led to the decision in 1893 to equip the cruisers Powerful and Terrible, each of 25,000 horse-power, with the Belleville boiler, while in the United States the Ward boilers were fitted to the monitor Monterey in 1892.

"From 1888 onward, the progress of the water-tube boiler has been swift. In torpedo craft it has long since vanquished its cylindrical competitor, and the change is complete, since the requirement in these boats of very high speed with small displacement has forced the development of the greatest possible boiler power on the least possible allowances for weight and space, while the locomotive boiler—the immediate predecessor of the water-tube in this service—was not only relatively heavy, but, under the necessary limitations as to weight and space, required an air pressure sometimes reaching 8 inches, to develop the power required."

In the United States navy the cylindrical boiler is still in use in the older vessels, but its day in that field has passed. The last battleships thus equipped were those of the Wisconsin class, contracted for in 1896, and all subsequent installations have been of the water-tube type.

Mr. Cathcart reviews the action of the Boiler Committee of the Admiralty, and ex-

amines the recommendation for the combined use of both types for the present in the Royal Navy.

"This policy, which has been tried, and, in the latest vessels abandoned by both the United States and Germany, will probably be but partial and temporary in Great Britain. As compared with the water-tube type, the combined installations have greater weight, less steam pressure, and some difficulties in operation. These disadavantages, with the steady advance of the water-tube boiler, will settle the question. As a whole, it may be said that the cylindrical boiler is, for the time at least, practically excluded from the recent vessels of the world's navies, since even the proposed British composite installations comprise but 20 per cent. of the total power required in each combination."

The satisfactory service which is given by the Scotch boiler in the merchant marine does not apply as an argument for its retention in naval vessels. In the case of merchant vessels the steaming is continuous and uniform, and the boiler passes from one port to another, is cleaned and repaired, and begins at once its return run. The naval service is altogether different in its character and requirements. A boiler may be pressed to its utmost capacity one day, and lie idle for weeks in succession. Under such conditions the cylindrical boiler has not given the satisfaction that has been obtained in continuous use, and these facts should be borne in mind when making the comparison.

The military value of the water-tube boiler is well brought out by considering its qualities under successive heads, these including the rapidity of raising steam, the endurance under strong forced draft, rapidity of construction and repair, weight saving, and lower danger from explosion. In all of these essentially military qualities the cylindrical boiler is deficient, as numerous citations show. In addition the water-tube system possesses greater flexibility of the installation, greater ease of cleaning water surfaces, and the possibility of higher steam pressures.

The objections which have been urged against the water-tube boiler have not been fully sustained. Thus the charge that they are not economical in continuous service is based upon limited information about non-representative cases. More recent trials have given results wholly favorable to the water-tube type, and with increased experience there is every reason to believe that the water-tube boiler will prove the more economical under all conditions. It has been maintained that there is a constant necessity for fresh feed water for the water-tube boiler, and that the increased weight of evaporators counterbalanced the gain in boiler weight. An ample supply of fresh water should also be supplied to cylindrical boilers, and when this provision is made the difference disappears.

The principal objection to which any force is admitted is that of the disablement of the boiler by the bursting of a single tube. The repair in the case of the latest types of water-tube boilers, however, have been greatly facilitated, and improvements in this respect are constantly being made.

There is no doubt that the best results with the water-tube boiler are attained only with the exercise of greater skill and attention than have been given to the cylindrical boilers.

"Intelligent firing is a factor of much importance in the aggregate efficiency of an installation including water-tube boilers. The amount of water contained is small as compared with the extent of heating surface, making steam generation a sensitive action, while the grates are wide with two or more doors, giving a sea barbarian fine opportunities for checking combustion by a fire of hills and hollows and by the frequent inrush of cold air through doors open too often and too long. What is required is simply a fire of even and moderate depth throughout, with coal fed at regular intervals and in regular order through the various doors. Without system and a fair amount of intelligence and training in this, the efficiency of the boiler will be seriously impaired.

"It seems clear that the water-tube boiler, in some forms at least, has reached a stage of development which makes the use of the cylindrical type in war vessels a grave military error in the sacrifice of such advantages as rapidity in raising steam, forcing in emergency without detriment, swift construction and repair, and weight-saving which can be utilized in added speed, armor or armament. The cylindrical boiler has so blocked progress in these paths that its usefulness as a war instrument seems

ended. As to the objections urged so often against the water-tube type with regard to complexity and sensitiveness in operation, it may be said that these conditions are relative only, and vary widely with different boilers. Even if this were not so, such objections cannot be considered as a bar to added military strength. Nelson's short and sightless smoothbores, with their excessive windage to allow for hot shot, were somewhat less complex and less difficult of operation than the massive rifles of to-day with their actuating mechanism. The leading boiler need of the present seems to be not so much further development as the thorough training of the fireroom force to meet the new conditions and to maintain the trial efficiency of the water-tube boiler in cruising duty."

FILTRATION AND TYPHOID.

REPORT OF DR. GEORGE A. SOPER UPON THE CAUSES OF THE EPIDEMIC OF TYPHOID FEVER AT BUTLER, PENNSYLVANIA.

Engineering News.

FORMERLY epidemics of diseases were considered as matters wholly for the consideration and efforts of the physician; to-day they fall largely within the scope of the work of the engineer. An epidemic of typhoid fever breaks out in a Pennsylvania town, and an engineer is sent by an engineering paper to present the causes and the methods of prevention before the engineering profession, and the whole affair is considered as an engineering question. The epidemic of typhoid fever in the town of Butler, Pennsylvania, has thus been made the subject of a special investigation by Dr. George A. Soper, and his report appears in a recent issue of *Engineering News*, by which paper he was sent to the place under consideration.

Apart from the immediate interest of the case under consideration, the matter possesses the broad aspect of representing the conditions of hundreds of other towns in various parts of the United States, in any one of which the conditions and results might be repeated at any time, and hence the report is of more than local interest and importance. The report of Dr. Soper gives the details of the situation at Butler very fully, and for these the reader is referred to the original document, but here we may give the general state of affairs, and show their bearing upon the whole subject.

Briefly, Butler is an excellent example of the prosperous American town, which while increasing in population and importance, has not outgrown petty village methods. The government resembles that of a city in form but remains that of a hamlet in fact, and the inevitable consequences follow sooner or later.

A waterworks is installed, and being under the general control of a company in a neighboring city which makes a business of such cases it is fairly well planned and operated. The supply is taken from a stream which flows through the town, but the intake is situated at a reasonably safe distance above, a reservoir being formed by a dam, and the water brought down to the pumping station through mains. Here mechanical filters, using a coagulant, are installed, so that a reasonably pure supply, fairly well filtered, has been delivered to the town, with the result of a good general health record, so far as can be ascertained. The village methods, however, include such an imperfect system of reports that the records are wholly worthless, as may well be seen from the fact that when 1,000 known cases of typhoid fever were under treatment by the physicians, but 42 had been reported.

Two things happened, however, and then trouble began. The first was the breakdown of the dam at the impounding reservoir above the town, and while the repairs were being made water was taken directly from the stream opposite the town, although numerous sources of pollution were plainly in evidence. The second event was the temporary stoppage of the use of the filtration plant, due to changes in pipe connections because of the installation of an additional pumping engine, so that for a short period the unfiltered water of the polluted stream was served out to the unsuspecting residents. Dr. Soper says: "Toward the close of October the

filters were shut down to permit a connection to be made with a new pump. They remained out of service for a period of ten days. During these ten days the water was not filtered. It is practically certain that the germs which caused the epidemic entered the water supply in this interval." The filters were out of service from October 20 to October 31; the epidemic of typhoid fever broke out on November 2.

The connection between causes and results can hardly be more clearly set forth than by the above plain statement of facts. A fairly pure supply of water, reasonably well filtered was accompanied by general good health. Even when a polluted supply was substituted no bad results appeared so long as the filter plant was interposed between the contaminated water and the inhabitants. When, however, this last barrier was removed the disease immediately appeared. As if further to confirm the correctness of the deduction, it appears that in one section of the town comparative immunity from the disease existed, and upon investigation it was found that this section was not supplied with the polluted water, receiving water from artesian wells.

According to the report of Dr. Soper, the filter plant was not supposed to have a high bacterial efficiency, being intended to remove clay and other earthy impurities only, but it is evident that it did keep the fever germs out so long as it was in action, and hence that even an imperfect filter is far better than none. The filter plant consisted of six open gravity filters of 15 feet diameter, and 8 feet depth, the filtering material being composed of 6 inches of gravel and 4½ feet of quartz sand, sulphate of alumina being employed as a coagulant. The increased demand for pure water, due to the rapid growth of the town, together with the effect of the present epidemic, will probably lead to the extension or improvement of this filtration plant, but, even such as it is, it has demonstrated most clearly the great value of filtration as a defence against the spread of disease in drinking water.

The lesson of Butler will doubtless be well remembered by the inhabitants of that town, but it would not require a long search to discover many other such places, where the conditions are ripe for an epidemic, and where some slight barrier, easily and unconsciously broken down or removed, may next release the germs of disease and death. Under present conditions nearly every availeble source of water supply is either already polluted or may become so without warning or indication. It will not do to depend upon any supposed pure source of supply, and no such chances should be taken. Proper purification is the only method of safety, and experience has demonstrated that filtration provides a satisfactory purification.

NON-REVERSIBLE MARINE ENGINES.

METHODS OF EMPLOYING NON-REVERSIBLE ENGINES TO ADVANTAGE IN CONNECTION WITH THE PROPULSION OF VESSELS.

Institution of Engineers and Shipbuilders in Scotland.

ONE of the developments which is accepted as certain to follow the improvements in the steam turbine and in internal-combustion motors is their application to marine propulsion; and, in fact, the first important installations of the Parsons turbine were on board the small high-speed vessels which have contributed so much to the fame of the motor. The practical difficulty with these motors, however, is found in the impracticability of reversing them with that promptness and certainty which is so important in manœuvring a vessel, and hence it has generally been found necessary to effect the reversal in some other portion of the mechanism of propulsion.

This subject is discussed in an interesting manner in a paper recently presented before the Institution of Engineers and Shipbuilders in Scotland by Mr. Rankin Kennedy, and published in the *Transactions* of the Institution, and we make some abstract of his treatment.

The steam turbine has been applied to a number of vessels, and the question of reversal has been met by the employment of an auxiliary turbine for backing, this being considered practicable in view of the fact

that backing is generally performed at low speeds and for short periods of time. It is desirable, however, that the full motive power of a vessel shall be promptly available for propulsion in either direction, and unless the improved motors are able to do this with the same facility as now exists with the marine engine they remain at a manifest disadvantage.

Various methods are now in use for reversing the direction of propulsion without changing the direction of rotation of the engine. Those generally employed with small vessels involve some change in the action of the screw propeller, such as reversing the angle of the blades by means of a sliding rod through a hollow shaft, or by reversing the direction of its rotation by change gears and clutches. In some cases both right and left hand screws are used, one or the other being locked to the shaft by a clutch system.

For larger vessels such methods are inapplicable, as they do not permit of the necessary strength and stiffness in the important connections between the engines and the screw, and some other plan becomes necessary. Mr. Kennedy examines two methods, discussing their merits at length.

The first of these involves the use of electric transmission between the engine and the propeller. The engine drives a dynamo and the propeller is driven by an electric motor. When the propeller is to be reversed its motor is reversed, while the engine and dynamo continue in the original direction of rotation. In many ways this plan offers much to attract the engineer. The long and troublesome shaft connection between the engine and the propeller disappears, and but a moderate length of shafting is needed aft, including the thrust bearing. The speed of the engine remains uniform, and may be anything best adapted for efficiency and convenience. A small high-speed steam turbine may be used to run a suitable dynamo, while the motor is proportioned to the best speed for the screw. The machinery may be placed wherever convenience indicates while all the control can be centralized on the bridge, a feature of great value. This plan is available alike for steam turbines or for internal-combustion motors, and the only objections which may be urged against it are the losses in efficiency in the double conversion from mechanical to electrical energy and back again, and the limitations at present existing in the size and power of electric motors.

A second method suggested by Mr. Kennedy involves the use of hydraulic jet propulsion. This in itself may suffice at once to condemn it in the eyes of many engineers, but there is no reason why a properly designed jet system may not be employed to advantage. The screw propeller itself is nothing more than a large jet pump, and the difficulty with jet systems which have placed the pump on shipboard has invariably been that they used a jet of too small section and too high velocity.

"It may at once be admitted that the jet propeller has some well-defined limitations which will prevent it ever becoming a better propeller than a screw in large steam-driven ships employing reciprocating or other reversible engines. The column of water set in motion to produce the jet is limited in sectional area. In Ruthven's *Waterwitch*, built in 1867, the area of the jets combined was 6.28 square feet, equal to 1-53 of the midship section of the vessel, and the efficiency was 0.18. In Thornycroft's hydraulic vessel, built in 1883, the area of the jets combined was about 1 square foot, equal to 1-14 of the midship section, and the efficiency was 0.254. Efficiency depends to a large extent upon the sectional area of the jet being a very large fraction of the midship section.

"The presence of a large volume of water on board the vessel is the chief drawback to the jet propeller. But by good design this volume can be much reduced, for, although the water must leave the vessel at a slow velocity in a large volume, it may pass along inside the vessel at a high velocity in a smaller column."

The modern forms of centrifugal pumps, operating in series, and driven at very high rotative velocities by the steam turbine, enable high-velocity jets of water to be obtained with a small and light mechanism, and the use of such jets to induce large-volume, slow-moving jets for the actual propelling effect is entirely practicable. With such a device the reversing of the direction of the vessel is readily effected by reversing the discharge direction of the jet, the engine and pumps maintaining a

continuous, unvarying direction of rotation.

Mr. Kennedy calls attention to the fact that certain internal combustion engines are reversible, citing especially the Bertheau three-cylinder oil engine. used by Thornycroft. The Diesel engine is also readily reversible, and has been applied with success for the propulsion of vessels in a manner altogether similar to the ordinary marine engine.

While the various methods discussed in the paper of Mr. Kennedy are of interest, they all depend upon the progress which may yet be made in the various forms of construction involved. The jet propeller is as yet not a success, although the reasons for this are well understood. Until now there has been no good reason for developing it in connection with existing reciprocating steam engines, but if its perfection is essential for the full application of the steam turbine to marine propulsion, it will undoubtedly be so perfected. The electrical method involves the construction of large and powerful motors, adapted for the onerous conditions of marine service, but there is little doubt that such motors could be promptly produced upon demand, while with an efficiency of 90 per cent. each for generator and motor a joint efficiency of more than 80 per cent. would be available, and it is not at all certain that this is lower than is now attained with long shafts supported on flexible hulls in rough weather.

PRACTICAL ADVANTAGES OF SUPERHEATING.

THE BENEFITS OF SUPERHEATING AS APPLIED TO EXISTING STEAM ENGINES OF IMPERFECT DESIGN.

M. Delaporte—Revue de Mécanique.

IT is one thing to discuss an engineering problem from the fundamental principles and to be able to apply those principles in apparatus of entirely new design, but it is altogether a different matter to assume that a complete theoretical analysis can be applied to existing installations, designed and constructed according to methods and ideas of an entirely different kind. It is undoubtedly for this reason that contradictory results are obtained in many instances in which it is attempted to apply scientific principles to old appliances. An excellent example of this difficulty is seen in the attempts to use superheated steam, and to obtain in practice the benefits which undoubtedly belong to it in theory. In a paper in a recent issue of the *Revue de Mécanique*, M. Delaporte examines the real advantages which may be expected from the use of superheated steam, taking into account the important fact that the medium is to be used in existing engines, machines admittedly imperfect appliances for the conversion of heat energy into mechanical power.

The discrepancies found between the computed and observed results in reciprocating steam engines have not been unexpected, since an important source of error is well understood to exist, namely the action of the cylinder walls upon the steam. Although a number of brilliant investigations have been made upon this important question our knowledge is still so imperfect that it is impossible to reduce the relations to the mathematical form of equations. Undoubtedly the internal condensation and reevaporation may be materially reduced by the employment of superheating, and with the diminution of losses from this cause we may be able to discover and study other sources of error. Here, however, we encounter a curious fact. In the case of the steam turbine the influence of changing temperatures of cylinder walls does not exist, because the continuous flow of steam through the machine causes each point to be maintained at a constant temperature. Under such conditions it would be reasonable to suppose that a close approximation to the theoretical performance would be attained, but experience has shown that with the steam turbine a marked improvement in economy is effected by superheating. Apparently the benefits of superheating are as great in those machines in which the injurious action of the walls does not exist as in the case where internal condensation is known to occur. A certain portion of the gain in the steam turbine with superheated steam has been attributed

to the diminished friction of the discs against the drier steam, but M. Delaporte considers this explanation wholly inadequate to account for the results of observation. On the contrary, he maintains that the discrepancy is due to an improper use of thermodynamic formulas, applying to machines essentially imperfect equations deduced from assumptions which are true only for perfect engines.

M. Delaporte makes a thorough mathematical examination of the actual conditions of heat transfer in engines of one and several cylinders, employing the temperature-entropy diagram, and also makes the same analysis for the steam turbine, but it is impracticable for us to discuss here in detail the results of these investigations. The general conclusions, however, show that the gain due to superheating is largely due to the fact that the machines are but imperfect appliances for the conversion of heat energy into work, and that it is upon this imperfect action that the possibility of gain depends.

An important element in all such computations is the fact that the specific heat of superheated steam is by no means accurately known. The value usually taken is that of Regnault, being 0.48 or 0.485, but this has been considered by many as being too low, and the recent researches of Bach, show that its value is probably more nearly equal to 0.6. Further experiments upon this question are greatly to be desired. The theoretical examination of this portion of the subject by M. Delaporte, using the equations of Zeuner, shows that the specific heat of saturated steam increases with the pressure, and also that, according to the investigations of Hirn, the value of the specific heat of superheated steam might reasonably be expected to be somewhere about 0.6 to 0.65.

While the practical advantages of superheating are not to be denied, there is certainly room for further experimental investigations into the true causes for the economy effected by its use. This is especially the case in connection with the rapid development of the steam turbine, as this motor bids fair to supersede the reciprocating engine for very many purposes, and improvements in its performance must depend very largely upon a correct knowledge of the thermodynamic principles involved. The whole subject forms material eminently suitable for work in the engineering laboratory, and although some excellent work has been done in this direction at Zürich and elsewhere, the matter is by no means exhausted.

GAS-ENGINE DESIGN.

RECENT DEVELOPMENTS IN THE CONSTRUCTION AND WORKING OF INTERNAL-COMBUSTION ENGINES.

D. S. Capper—Junior Institution of Engineers.

IT is remarkable that the internal-combustion motor has, until the last few years, remained almost entirely in the form and design which was given to it by Dr. Otto more than thirty years ago. Originally intended for small engines, the design has simply been magnified for larger ones, and the whole matter was treated empirically for a long time. Now that the demand for large engines has appeared, and the commercial world is demanding all that can be practically obtained as regards efficiency, uniformity of speed and continuity of operation, the internal-combustion motor has become the subject of serious study by the designing engineer, and on the whole with excellent results. An interesting review of the recent development in this line of work is found in a paper presented by Professor D. S. Capper before the Junior Institution of Engineers, from which we make some abstracts.

The first improvement of any importance made in the original Otto engine was the substitution of the incandescent tube for the troublesome flame ignition slide. This was followed by a revival of the use of electric ignition, originally employed by Lenoir in his historic engine, so that the flame ignition has been altogether abandoned. Electric ignition is now the rule, although the heat of compression or the accumulated

heat of combustion is used in some instances.

So far as improvements in efficiency are concerned, these mainly depend upon the increased degree of compression used. Thus Messrs. Crossley, the builders of the Otto engine in England have succeeded in raising the compression from 30 pounds per square inch to 100, or even 120, pounds. This involves correspondingly high combustion temperatures, and improved methods of cooling have been found necessary, exhaust valves and pistons, as well as cylinder barrels, being water-cooled.

"Thermodynamically, the raising of the compression pressure makes the compression correspond more closely to the adiabatic return from lowest to highest temperature of the Carnot cycle, but the isothermal stage of the Carnot cycle has to be omitted almost entirely. Moreover, with a rich, gaseous mixture the compression cannot be carried as high as desirable from the theoretical point of view, as the critical ignition pressure and temperature for the mixture would be reached and pre-ignition would automatically take place.

"The successive increases in compression pressure, accompanied by other improvements, have resulted in the consumption of coal-gas per brake horse-power in the Crossley engine being reduced from 25 cubic feet by successive stages to 17, 15 and 13.5 cubic feet per brake horse-power per hour, which means, with gas of calorific value equal to 680 foot-pounds per cubic foot, a thermal efficiency on the effective work of 27.6 per cent. With gas from a producer or blast-furnace the consumption would be greater in proportion to the quality of the gas.

The earliest attempt to construct an engine with a power stroke every revolution was made by Dugald Clerk about 1876, his engine being constructed with a separate compressing pump, instead of effecting the compression in the working cylinder. Clerk also introduced the practice of scavenging the cylinder with fresh air to remove the products of the previous combustion, and although his engine did not come into general use, many of the later designs include some of his original ideas.

Professor Capper reviews the improved engines constructed by the Westinghouse Company, by the Premier Gas Engine Company, by the Cockerill Company, by Messrs. Fielding and Platt, and others, these including multiple cylinders, vertical arrangement, governing by varying the gas mixture, and many improved structural details. In general the Otto cycle is still principally used, its drawbacks being overcome by the use of heavy fly-wheels, careful governing, and by the grouping of a number of cylinders round the crankshaft in such a manner as to reduce the floor space occupied to a minimum. Further, by improved arrangement of parts, reduction of clearance, and increased attention to minimizing the area in contact with the hottest gases and an accompanying increased efficiency and extent of cooling jacket, the engine is showing signs of developing into a double-acting engine. It has thus been found possible to obtain a direct gas-driven electric generator set, occupying no more space than a steam-driven set of equal power.

Professor Capper examines the Diesel motor at length, discussing especially its availability as a gas engine, and shows that it would require but slight modification to adapt it to gas fuel, and thus to realize the object long ago attempted by Sir William Siemens of producing a gas engine with constant-pressure ignition.

"From these facts it will be gathered that the gas engine has been, by recent improvements in construction brought to a position in which, in economy, it surpasses the steam-engine, and in regularity of running, steadiness, size and handiness for given power, it approaches very closely, and promises to surpass, the steam-engine also. Compound gas-engines have been tried by Messrs. Crossley and by other makers; but although these have been successfully worked, the gain has not been commensurate with the added cost, and they have therefore not been adopted as a commercially possible type.

"If the reciprocating engine were to give place to a rotary turbine, there is little doubt that its future bids fair to equal—probably to surpass—the steam-engine for universal applicability. Many experimenters are working on the problem of a gas-turbine, and there are even rumors that a solution has been found. There is little doubt that as Mr. Parsons has converted the engineer-

ing world to the real genuineness of an economical steam-turbine (though many of us had, from frequent disappointment, learned to regard a rotary engine as approaching perpetual motion in the improbability of its successful achievement), so the gas-turbine will in the future—possibly the near future—be an accomplished fact. The place the reciprocating gas-engine has already won is proved by the significant fact that even firms which have created the demand and met the supply for high-speed steam electric generators are almost without exception experimenting with gas engines as the coming thing which will supply the second, if not the first, string to their bow."

THE NEW SUSPENSION BRIDGE AT NEW YORK.

NOTES CONCERNING THE WILLIAMSBURG BRIDGE ACROSS THE EAST RIVER AT NEW YORK CITY.

Engineering News.

FOR more than twenty years the Brooklyn suspension bridge over the East River at New York has been one of the sights of the metropolis, both for its length of span and the importance of the traffic, as well as for the beauty of its appearance. Now, however, it has to share all of these features with a rival, since the greatly needed bridge spanning the same river about a mile and a half further north is completed and open for traffic.

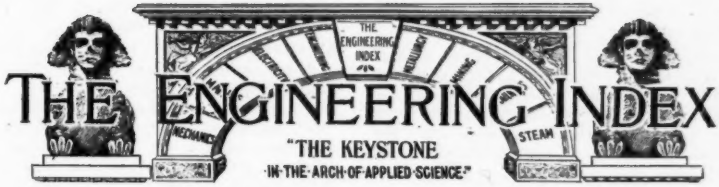
Illustrations and details of this important structure have already been given to the public in many of the engineering publications, but some salient features may here be noted for convenient reference, and from an excellent description in *Engineering News* we gather the following points.

The new bridge is five feet greater in span than the Brooklyn bridge, but in capacity for traffic it exceeds the older structure threefold, and it is in this respect especially that the new bridge is notable. Many bridges of great span have been constructed to meet the demand for a communication, important in character but limited in volume. The immense traffic between the two boroughs of New York, Manhattan and Brooklyn, has long since crowded the old suspension bridge to its limits, and every feature in the design of the new structure has been considered with a view of providing for the various kinds of transport demanded.

A few figures may be given to enable the old, or Brooklyn, bridge to be compared with the new, or Williamsburg, bridge. The Brooklyn bridge is of 1,595.5 feet clear span, and a total length of 5,989 feet. Its clear height of waterway beneath is 135 feet, and the width of the bridge structure proper is 85 feet. The Williamsburg bridge has a span of 1,600 feet and a clear height of 140 feet 4¾ inches above mean high water, while the width is 118 feet. The traffic capacity of the Williamsburg bridge is increased by making a portion of the suspended structure double deck, there being two roadways and two tramways for electric trolleys on the lower deck, while above there are two foot walks, two bicycle paths, and a double track way for the elevated railway. This arrangement will provide fully triple the transport capacity for the new bridge over the old, and this will doubtless materially relieve the crowding of the Brooklyn bridge, besides aiding to develop the section more directly reached by the new structure.

The principal differences in appearance between the new bridge and the Brooklyn bridge are of the towers, which are of structural steel instead of masonry, and in the much greater depth and stiffness of the suspended structure, this latter being practically an immense truss bridge supported by the cables instead of by piers. This latter feature gives the new bridge a great degree of stiffness, and it is expected that even with the greatest traffic of which the roadways are capable the deflection and vibration will be almost imperceptible.

The new bridge was commenced in October, 1897, and opened in December, 1903, and the total cost, exclusive of the site, was about $11,000,000; inclusive of the land, however, the cost has exceeded $20,000,000. The Chief Engineer of the bridge was Mr. L. L. Buck, and the Assistant Chief Engineer Mr. O. F. Nichols.



The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Basel.

The Temporary Bridge over the Rhine at Basel (Die Provisorische Rheinbrucke in Basel). Illustrating the wooden structure for use during the rebuilding of the middle bridge at Basel. 1500 w. Schweizerische Bauzeitung—Nov. 7, 1903. No. 59824 B.

Cantilevers.

Some Considerations on the Effect of Stresses on Cantilevers. T. Mackenzie. Considers a simple approximate method of determining the amount of vertical displacement, or the deflection of levers under various conditions of load, etc. 1600 w. Builder—Nov. 28, 1903. No. 59430 A.

Erection.

Erection of the Turtipar Bridge on Barges and Cantilever Falsework. Brief description of the unusual manner of erecting a bridge across the Gogra River, India. 700 w. Eng Rec—Dec. 5, 1903. No. 59475.

We supply copies of these articles. See page 796.

Floors.

Ballasted Floors on the Atchison, Topeka & Santa Fe. Drawings and description of ballasted bridge floors. 600 w. Ry Age—Nov. 27, 1903. No. 59365.

Moving.

Moving a Seine Bridge. Gives a brief illustrated description of a foot-bridge in Paris, which was moved to allow the erection of a new structure on the same site, explaining the conditions and the methods. 1600 w. Engr, Lond—Dec. 11, 1903. No. 59738 A.

Reinforced Concrete.

75-ft. Concrete Steel Arch on the Burlington. An illustrated description of a structure being built over Big Rock Creek, 51 miles from Chicago. 1000 w. R R Gaz—Dec. 1, 1903. No. 59522.

See also Civil Engineering, Construction.

Stress.

The Limits of Working Stress in Bridges. On the considerations which determine the limits of working stress in bridge structures, with examples of the limits actually adopted in the case of important bridges. 3500 w. Engr, Lond—Nov. 29, 1903. Serial, 1st part. No. 59349 A.

Suspension.

Eye-Bars or Cables for Manhattan Bridge. R. S. Buck. A comparison of theories and conditions, with detailed discussion of material cost, methods, &c. Also editorial. Illustrated. 11700 w. R R Gaz—Dec. 4, 1903. No. 59488.

The Manhattan Bridge Design. Gustav Lindenthal. A letter stating the reasons for the chain bridge. 1400 w. R R Gaz—Dec. 25, 1903. No. 59922.

The Superstructure for the Manhattan Bridge Across the East River at New York City. General description, with illustrated description of special details. 2000 w. Eng News—Dec. 10, 1903. No. 59526.

Towers and Anchorages of the Manhattan Bridge, New York. Illustrated description prepared from the specifications and drawings issued by Commissioner Lindenthal. 2000 w. Eng Rec—Dec. 12, 1903. No. 59595.

Transporter.

Transporter Bridges (Ponts à Transbordeur). G. Leinekugel Le Cocq. With illustrated descriptions of the bridges at Rouen, Bizerte and Nantes. A travelling car is suspended from a high level suspension bridge, thus permitting a clear waterway for ships. Two articles. Two plates. 5000 w. Génie Civil—Nov. 21, 28, 1903. No. 59802 each D.

Viaduct.

The Coatesville Viaduct of the Pennsylvania Railroad. An illustrated description of a four-track stone arch bridge now under construction. 800 w. Ry Age—Nov. 27, 1903. No. 59367.

Williamsburg Bridge.

Engineering Design of the Williamsburg Bridge. Leffert Lefferts Buck. An explanation of the design and of features suggested which have not been carried out in the construction of the new bridge over the East River, New York. 2000 w. R R Gaz—Dec. 25, 1903. No. 59923.

The Main Span of the Williamsburg Bridge, Across the East River, New York City. Begins an illustrated detailed description of the operation of erecting the suspended superstructure of this long-span bridge. 2000 w. Eng Rec—Dec. 19, 1903. No. 59668.

The Opening of the New East River Bridge, New York. An exhaustive illustrated account of the construction from the engineering standpoint. 9500 w. Sci Am Sup—Dec. 19, 1903. No. 59709.

The Williamsburg Bridge Across the East River at New York City. An illustrated detailed description of the construction of this bridge just opened to traffic. 11200 w. Eng News—Dec. 17, 1903. No. 59701.

CANALS, RIVERS AND HARBORS.

Breakwater.

The Breakwater at Buffalo, New York. Emile Low. An illustrated detailed description of breakwater construction and extension, with history of the projects for the formation of a harbor, maps, &c. 36400 w. Pro Am Soc of Civ Engrs—Nov., 1903. No. 59303 E.

Brussels.

Brussels as a Seaport (Bruxelles Maritime). E. Guarini. An account of the cutting of the canal which is to connect Brussels with the North Sea. 2000 w. Revue Technique—Nov. 25, 1903. No. 59829 D.

Canal Lifts.

Improved Methods of Overcoming High Canal Lifts (Neuere Vorschläge zur Ueberwindung Hoher Stufen in Schiffahrtskanälen). H. R. Rintelen. A review of various schemes for replacing canal locks, including movable tanks, inclined planes, etc. 5000 w. Glasers Annalen—Dec. 15, 1903. No. 59845 D.

Cofferdam.

Cofferdam for the 39th Street Pumping Station at Chicago. Illustrates and describes what is believed to be the largest

cofferdam ever built in open water. 500 w. Eng News—Dec. 17, 1903. No. 59703.

Current Meters.

See Mechanical Engineering, Hydraulics.

Dams.

Rolling Moveable Dams (Ueber Walzenwehre). M. Carstanjen. The dam is made in the form of a large cylindrical drum, which can be rolled up inclined ways to permit the free passage of flood water. Details and illustrations of existing installations are given. 5000 w. Zeitschur d Oesterr Ing u Arch Ver—Dec. 11, 1903. No. 59822 D.

See Also Civil Engineering, Water Supply.

Docks.

Dock Improvements at Liverpool. Discussion of a paper by George Cecil Kenyon. 1200 w. Pro Am Soc of Civ Engrs—Dec. 1903. No. 59785 E.

Dortmund-Ems.

The Dortmund-Ems Canal and Henrichenburg Canal Lift. An illustrated detailed description of this famous canal lift, with outline of the project of which it forms a part. 4800 w. Trac & Trans—Dec., 1903. Serial. 1st part. No. 59629 E.

Dredging.

A Desirable Method of Dredging Channels Through River Bars. Discussion by Messrs. Rudolph Hering and W. W. Harts, of a paper by S. Maximoff. 1500 w. Pro Am Soc of Civ Engrs—Dec., 1903. No. 59787 E.

Dredging Plant and Clyde Improvement. Illustrated description of a powerful twin-screw barge-loading dredge built for work on the Clyde. 1200 w. Engr, Lond—Dec. 18, 1903. No. 59781 A.

The Chaquette Pneumatic Dredge. C. E. Davenport. An illustrated detailed description of a power clamshell for dredging or excavating. 2700 w. Compressed Air—Dec., 1903. No. 59558.

Dry Docks.

See Marine and Naval Engineering.

Harbors.

Notes on Harbor Works and Harbor Plant. Discusses the principal types of machines and plant used in harbor, pier and breakwater work at the present time. 3200 w. Builder—Dec. 19, 1903. Serial. 1st part. No. 59760 A.

Italy.

Internal Navigation in Italy (La Navigazione Interna in Italia). G. Cattaneo. An examination of present conditions, together with future plans, with especial reference to the canalisation of the rivers of Northern Italy. 10000 w. 2 plates. Rivista Marittima—Aug., Sept., 1903. No. 59871 H.

New York.

Recent Changes in the Elevation of Land and Sea in the Vicinity of New York. Abstract of a paper by George W. Tuttle. Gives conclusions reached as the result of a study of tidal observations—1500 w. Eng Rec—Dec. 12, 1903. No. 59596.

Panama.

Organization and Personnel in the Building of the Panama Canal. Fullerton L. Waldo. A discussion of an outline of practical plans for the actual construction work on the canal. 2500 w. Engineering Magazine—Jan., 1903. No. 59883 B.

Notes on Panama and Colombia. An account giving population, area, and general information of each. Ill. 1600 w. Nat Geog Mag—Dec., 1903. No. 59381 C.

The Solution of the Isthmian Canal Problem. Gen. H. L. Abbot. A review of the dangers which have been escaped by the choice of the Panama route for the Isthmian Canal. 3000 w. Engineering Magazine—Jan., 1903. No. 59882 B.

River Improvement.

The Work of the Madison Park and Pleasure Drive Association, Madison, Wis. W. D. Taylor. Illustrates and describes the improvement of the Yahara River by cleaning and deepening the river bed by dredging, raising the bridges, securing the land on both banks for driveways, etc. 1500 w. Eng News—Dec. 10, 1903. No. 59524.

CONSTRUCTION.

Domes.

Theory of the Spherical Dome with a Homogeneous Surface, and of the Framed Dome; Also Notes on the Construction of Masonry and Metal Domes. E. Schmitt. Gives original information, and shows the relation between the principal stresses in domes, and their magnitude; and presents a method of framed dome construction. Ill. 8000 w. Pro Am Soc of Civ Engrs—Dec., 1903. No. 59784 E.

Erection.

A Comparison of English and American Methods in the Erection of Buildings. Charles Heathcote. Read before the Inst. of Builders. 5200 w. Builder—Dec. 5, 1903. No. 59611 A.

Excavating.

The Practical Working of Trench Excavating Machinery. Ernest McCullough. Illustrates and describes a trench-excavating machine and its operation. 2500 w. Eng News—Dec. 24, 1903. No. 59755.

Foundations.

Foundations. Baron H. T. H. Siccama. Read before the Civ. & Mech. Engrs, Soc. and printed in the *Building News*. An interesting review of systems used in alluvial soils. 3800 w. Am Archt—Dec. 19, 1903. No. 59661.

Grain Elevator.

The Southern Pacific Elevator, Galveston, Texas. Illustrated description of an interesting engineering work. 3500 w. Eng Rec—Dec. 5 1903. No. 59473.

Granite Columns.

The Production and Transportation of the Granite Columns for St. John's Cathedral, New York City. An illustrated article describing this difficult work and explaining the methods adopted. 2800 w. Eng News—Dec. 3, 1903. No. 59486.

Reinforced Concrete.

An Armored Concrete Building for the College of Music, Cincinnati. Brief description of moderate cost, fire-resisting building, with illustrations of details. 1000 w. Eng Rec—Nov 28, 1903. No. 59377.

A Suspended Curved Double Stairway of Reinforced Concrete. Illustrates and describes a winding stairway being built in the New York residence of Mr. George W. Vanderbilt. 1500 w. Eng Rec—Dec. 12, 1903. No. 59594.

Concrete Metal Construction. Emile Villet. An illustrated description of work in the art of armoured cement construction, discussing the wharf at the port of Novorossisk, on the Black Sea, Russia; the wharf for the Department of Docks, of New York; and a proposed sea-wall for San Francisco. 3700 w. Jour Assn of Engng Soc's—Oct., 1903. No. 59576 C.

Concrete-Steel Columns for Reinforcing an Old Building. Keith O. Guthrie. Illustrated description of method adopted to strengthen 10th Sub Station of the Louisville Lighting Co. 1000 w. Eng News—Dec. 17, 1903. No. 59704.

Ferroinclave—A Fireproof Building material. H. F. Cobb. Read before the Civil Engr.'s Club of Cleveland. An illustrated description of a fireproof roofing construction of reinforced concrete. 2800 w. Ir Trd Rev—Dec. 17, 1903. No. 59684.

The Concrete-Steel Stadium on the Athletic Field of Harvard University. Illustrations and description of a structure being erected for open-air games. 2200 w. Eng Rec—Dec. 12, 1903. No. 59597.

See Also Civil Engineering, Bridges.

Roads.

Good Roads. George C. Diehl. Reviews what has been done in road improvement, the methods employed to advance the work, &c. 3000 w. Jour Assn of Engng Soc's—Oct., 1903. No. 59575 C.

Roofs.

Roofing Existing Shops While Work is Proceeding. R. H. Fowler. An illustrated description of methods used in reroofing the shops of the steam plough works at Leeds, Eng. 1600 w. Inst of Mech Engrs—Nov. 20, 1903. No. 59313 D.

Some Roof Trusses in the Hotel Astor. Description, diagrams and details of mansard roof framing. 1500 w. Eng Rec—Dec. 5, 1903. No. 59474.

Subaqueous Construction.

An Improved Method of Subaqueous Construction at the Harlem River Crossing of the New York Rapid Transit Railroad. Illustrates and describes the method used near 145th street. 1300 w. Eng Rec—Dec. 26, 1903. No. 59909.

Tunnels.

Some Tunnel Work on the Pittsburg, Carnegie & Western R. R. An illustrated account of tunnels now under construction on the Wabash R. R. extension, having features of unusual engineering interest. 3000 w. Ry & Eng Rev—Dec. 5, 1903. No. 59464.

The Cost of Concrete Tunnel Lining and of Tunnel Excavation. George W. Lee. An illustrated article describing methods of construction and giving figures showing the cost of this kind of work. 1800 w. Eng News—Dec. 17, 1903. No. 59699.

The East River Tunnel. Interesting illustration with description of construction work on this tunnel which is to connect Brooklyn and Manhattan. 1800 w. Compressed Air—Dec., 1903. No. 59559.

The Present Status of the Hudson River Tunnel. Reviews the history of the construction work of the tunnel begun 30 years ago. 1200 w. Ir Age—Dec. 17, 1903. No. 59626.

Underpinning.

Underpinning an Old Office Building on Broadway, New York. Diagram and description of counter-weighted cantilever needle beams and girders for underpinning, and methods used. 1000 w. Eng Rec—Dec. 5, 1903. No. 59476.

Ventilation.

Distribution of Air. Alton D. Adams. The present article is introductory, showing the great importance of proper ventilation, and causes of vitiation. 2000 w. Archts & Builders Mag—Dec., 1903. Serial. 1st part. No. 59443 C.

MATERIALS.

Cement.

Edison Portland Cement Company. An

illustrated description of the extensive plant at New Village, N. J., and the novel processes of manufacture employed. 6500 w. Ir Age—Dec. 24, 1903. No. 59743.

The Edison Portland Cement Works at New Village, N. J. An illustrated detailed description of these works and their operation. The distinctive feature is the use of roll crushers and grinders. Also editorial. 5500 w. Eng News—Dec. 24, 1903. No. 59794.

The Fatigue of Cement-Products. Discussion of paper by J. L. Van Ornum. 1500 w. Pro Am Soc of Civ Engrs—Nov., 1903. No. 59304 E.

The Manufacture of Artificial Portland Cement (Fabrication du Ciment Portland Artificiel). A. Morel. A general description of the different processes, furnaces, and grinding machinery. Three articles. 5000 w. Génie Civil—Nov. 28, Dec. 5, 12, 1903. No. 59804 each D.

The Plant of the Northampton Portland Cement Company. Richard K. Meade. Illustrated detailed description. 2000 w. Eng Rec—Dec. 5, 1903. No. 59472.

Concrete.

Mixing and Placing Concrete. Samuel H. Lea. Discusses placing forms, facing, methods of handling under water or in freezing weather, waterproofing, etc. Ill. 6000 w. Mines & Min—Dec., 1903. No. 59385 C.

Staff.

Staff—Its Use and Treatment. J. S. Crawford. An illustrated article giving facts of interest in regard to the treatment of this material, which is extensively used in exposition buildings and their ornamentation. 3000 w. Sci Am—Dec. 5, 1903. No. 59479.

MEASUREMENT.

Surveying.

The Accuracy of Surveying Measurements for Tunneling (Ueber den Genauigkeitsgrad der Messungen für Anlage und Bau von Tunneln). F. Haller. Discussing the method of determining the probable error in a system of triangulation. 2000 w. Schweizerische Bauzeitung—Nov. 7, 1903. No. 59825 B.

Theodolite.

Ferguson's "Percentage" Theodolite. Illustrates and describes a tacheometer theodolite in which is embodied a method of graduating the arcs. 800 w. Engng—Dec. 4, 1903. No. 59636 A.

MUNICIPAL.

Pavements.

Use of Medina Sandstone for Pavements in Brooklyn, New York City. C. D. Pollock. Gives the specifications for blocks and methods of laying. 1200 w. Eng Rec—Dec. 26, 1903. No. 59906.

Sewage.

Sewage Disposal at Provincial Gaol, Victoria, B. C. E. Mohun. Drawing and description of the method adopted in an isolated plant. 1100 w. Can Soc of Civ Engrs, Adv proof—Dec., 1903. No. 59675 D.

Sewage Disposal in Providence. Illustrated description of a plant employing the chemical precipitation method, its cost and operation. 1500 w. Munic Jour & Engr—Dec., 1903. No. 59409 C.

Sewage Disposal. Rudolph Hering. Part of a paper read before the League of Am. Munic. Cives an expert's views, describing the practice in foreign cities, and the best methods in the United States. 2000 w. Munic Jour & Engr—Dec., 1903. No. 59410 C.

The Use of Sewage for Irrigation After Treatment in Septic Tanks in Tropical Countries. E. O. Mawson. Deals with small schemes, suitable for medium-sized towns, showing how the sewage can be turned to profit. 3000 w. Fielden's Mag—Dec., 1903. No. 59619 A.

Sewer Construction.

Inverted Syphons in the Sewage System of Newton, Mass. Irving T. Farnham. Explains why these syphons were necessary and their essential features. Ill. 1000 w. Munic Engng—Dec., 1903. No. 59548 C.

Smoke.

The Smoke Problem of Denver. Thomas L. Wilkinson. The present article gives a survey of what has been done in other cities to abate the smoke nuisance. It will next consider combustion in boiler furnaces, showing how the smoke may be overcome. 2200 w. Min Rept—Dec. 10, 1903. Serial. 1st part. No. 59605.

WATER SUPPLY.

Cleveland, O.

The New Water Supply Tunnel of Cleveland, Ohio. Charles Goffing. Gives a brief resumé of the history of the East Side lake tunnel and its construction. 1500 w. Eng Rec—Dec. 12, 1903. No. 59599.

Consumption.

Water Consumption in American Cities. E. Kuichling. A study in water meter statistics by an expert engineer. 1500 w. Munic Jour & Engr—Dec., 1903. No. 59412 C.

Dam.

The Walden Pond Dam of the Lynn Water Works. George I. Leland. Reviews the history of the supply, and gives

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an illustrated description of the work of raising this dam 20 feet. 3000 w. Eng Rec—Dec. 19, 1903. No. 59670.

Filtration.

Filtration for Public Water Supplies, with Especial Reference to the Double Filtration Plant at Bremen, Germany. Discussion of the paper by Eugen Goetze, Esq. 4500 w. Pro Am Soc of Civ Engrs—Nov., 1903. No. 59305 E.

Filtration for Public Water Supplies, with Especial Reference to the Double Filtration Plant at Bremen, Germany. Continued discussion of a paper on this subject by Eugen Goetze. 12400 w. Pro Am Soc of Civ Engrs—Dec., 1903. No. 59786 E.

The Mechanical Filter Plant for the Danville Water Company. An illustrated detailed description of new works. 1800 w. Eng Rec—Dec. 26, 1903. No. 59905.

The Use of Sulphate of Iron at Lorain. C. Arthur Brown. Report concerning changes made in a filtration plant on Lake Erie, the methods of analysis, results obtained, &c. 2800 w. Eng Rec—Dec. 5, 1903. No. 59478.

New York City.

Abstract of report of the Commission on an Additional Water Supply for New York City. With map and editorial comment. 5000 w. Eng Rec—Dec. 19, 1903. No. 59675.

Final Report of the Commission on Additional Water Supply for the City of New York. Abstract and map. 1500 w. Eng News—Dec. 24, 1903. No. 59798.

Ozone.

Recent Applications of Ozone in Water Sterilization (Weitere Beiträge zur Technik der Ozonwasserwerk). Dr. G. E. Erlwein. Data and results of recent investigations into the sterilization of drinking water by ozone. 3000 w. Gesundheits-Ingenieur—Oct. 31, 1903. No. 59878 D.

See also Electrical Engineering, Electrochemistery.

Pollution.

The Typhoid Fever Epidemic at Butler, Pa. George A. Soper. Report of investigation showing the epidemic to be due to the use of polluted water, by reason of the interruption in the operation of the filter plant. 6000 w. Eng News—Dec. 24, 1903. No. 59799.

Rainfall.

Rainfall and Run-Off of New England, Atlantic Coast and Southern Colorado Streams. William O. Webber. Tabulated information with explanatory notes. General discussion. 15000 w. Jour Assn of Enging Socs—Nov., 1903. No. 59788 C.

Reservoirs.

New Reservoir at Portland. Description of basin just completed near Sebage Lake, Maine. 1800 w. Fire & Water—Dec. 5, 1903. No. 59463,

The Cedar Grove Reservoir of the Newark, N. J., Waterworks. The present article gives a general illustrated description, dams, and contractor's plant. 2500 w. Eng Rec—Dec. 5, 1903. Serial. 1st part. No. 59471.

The Staines Reservoirs and Aqueducts of the London Water Works. Illustrated detailed description. 4500 w. Eng Rec—Nov. 28, 1903. No. 59375.

Springfield, O.

Springfield's Water Supply. L. Walter Harrison. A description of a water supply filtered by nature. Ills. 1000 w. Munic Jour & Engr—Dec., 1903. No. 59411 C.

MISCELLANY.

Drainage.

Some Engineering Features of Drainage. C. G. Elliott. From the *Year Book* of Department of Agriculture. Considers briefly drainage of rainfall, surface storage, irrigated lands, etc., etc. Ill. 6000 w. Sci Am Sup—Dec. 5, 1903. No. 59482.

House Raising.

Raising a Brick Dwelling One Hundred and Sixty Feet. Illustrates and describes a remarkable job of house raising and moving recently successfully accomplished in Pittsburg. 1200 w. Eng Rec—Dec. 19, 1903. No. 59674.

Rural Engineering.

Rural Engineering. Condensed report of the Committee on Rural Engineering of the Assn. of Am. Agri. Colleges and Ex. Stations. Deals with drainage, irrigation, farm requirements, etc. 3000 w. Eng News—Dec. 24, 1903. No. 59796.

ELECTRICAL ENGINEERING

COMMUNICATION.

Space Telegraphy.

A New Wave Detector for Wireless Telegraphy (Ein Neuer Wellendetektor für Drahtlose Telegraphie). W. Schloemilch. Describing a new form of electrolytic detector, using a polarized cell. 2000 w. Elektrotech Zeitschr—Nov. 19, 1903. No. 59855 B.

Concerning Wireless Telegraph Trans-

mitters. Lee de Forest. Discusses some of the causes of failure, and reviews points that should be observed in the erection of apparatus. 1800 w. Elect'n, Lond—Nov. 27, 1903. No. 59435 A.

Electrical Notes from Europe. Illustrates and describes the automatic wireless telegraph post at Paris, and the new Blondel-Carpentier hysteresimeter. 2500 w. Elec Rev, N. Y.—Dec. 5, 1903. No. 59466.

Some New Experiments in Syntonic Wireless Telegraphy in the Italian Navy. Describes experiments of considerable interest. 3700 w. Sci Am Sup—Nov. 28, 1903. No. 59338.

The Multiplication Scale as a Wave Measurer for Space Telegraphy (Der Multiplikationsstab ein Wellenmesser für die Funkentelegraphie). A. Slaby. A discussion of the author's methods for syntonizing apparatus for selective space telegraphy. 5000 w. Elektrotech Zeitschr —Dec. 10, 1903. No. 59862 B.

Telephone Exchange.

Methods of Signaling and Operating in Telephone Exchanges. Kempster B. Miller and Charles S. Winston. Explains some points in the standardized practice, and why they are regardless, as far as possible, of any circuit arrangement. 2500 w. Elec Wld & Engr—Dec. 5, 1903. Serial. 1st part. No. 59493.

The Exchange of the Frontier Telephone Company, Buffalo, N. Y. Virgil Hayden. Illustrated description. 2400 w. Elec Rev, N. Y.—Dec. 26, 1903. No. 59916.

The New Douglas Exchange of the Chicago Telephone Company. Illustrated description. 4500 w. Am Elect'n—Dec., 1903. No. 59415.

Telephony.

Some Elements Inherent in Automatic Telephony Which Make It Popular. Joseph B. Baker. Discusses the character and advantage of the automatic service. 1700 w. Elec Rev, N. Y.—Dec. 12, 1903 No. 59577.

Transmitters.

Telephone Transmitters. Arthur V. Abbott. Explains the three principles upon one of which every transmitter operates, and discusses microphonic contact in the present article. Ill. 2800 w. Elec Wld & Engr—Dec. 5, 1903. Serial. 1st part. No. 59494.

DISTRIBUTION.

Converter.

Investigations of the Pulsation of the Continuous Current in a Rotary Converter (Untersuchungen über die Pulsation des Gleichstromes bei dem Rotierenden Umformer). E. Cramer. A repetition of the investigations of Banti, showing the influence of the pulsations upon the determination of efficiency. 7000 w. Elektrotech Zeitschr—Nov. 19, 1903. No. 59854 B.

Montreal.

Montreal the Greatest Center of Transmitted Power. Alton D. Adams. The first installment of an illustrated account of the Montreal system. A great consolidation and the long-distance transmission problem are being worked out. 4000 w. Elec Wld & Engr—Dec. 5, 1903. Serial. 1st part. No. 59492.

Overhead Systems.

Overhead High-Tension Distributing Systems in Suburban Districts. George H. Lukes. Calls attention to certain points in pole line construction which experience has shown to be often neglected. 1600 w. Trans Am Inst of Elec Engrs—Dec. 18, 1903. No. 59652 D.

Safeguards and Regulations in Operation of Overhead Distributing System. W. C. L. Eglin. Discusses the conditions that must be considered in the construction of the line, the safety devices and their action, inspection, etc. 2800 w. Trans Am Inst of Elec Engrs—Dec. 18, 1903. No. 59654 D.

Regulation.

Automatic Apparatus for Regulating Generator and Feeder Potentials. E. J. Bechtel. Describes types of automatic generator potential regulators using different methods to accomplish the result. Ill. 1000 w. Trans Am Inst of Elec Engrs—Dec. 18, 1903. No. 59653 D.

Theft.

Theft of Current. Robert L. Elliott. Discusses some of the methods adopted by offenders, the discovery and prevention. 4800 w. Cent Sta—Dec., 1903. No. 59602.

ELECTRO-CHEMISTRY.

Accumulator.

See Mechanical Engineering, Automobiles.

Copper Refining.

Contact Resistances and Current Leakages in an Electrolytic Copper Refinery. Benjamin Magnus. Gives results of tests on tank leakages. Ill. 800 w. Elec-Chem Ind—Dec. 1903. No. 59514 C.

Deposition.

The Rapid Electro Deposition of Copper (Infringement Processes). Discusses what has been accomplished by this method. 1100 w. Elec-Chem and Met—Nov., 1903. No. 59651 E.

Electric Smelting.

Kjillin's Electric Furnace of Gysinge, Sweden, for the Manufacture of Steel.

We supply copies of these articles. See page 796.

Frank G. Perkins. Illustrated description. 1500 w. Elec-Chem Ind—Dec, 1903. No. 59516 C.

Production of Iron and Steel in the Electric Furnace. Dr. H. Goldschmidt. Abstract translation from the *Zeitschrift für Elektrochemie.* A descriptive article on electrical smelting of iron, giving a comparative statement of the various processes, the cost, &c. Ill. 3000 w. Elect'n, Lond—Nov. 20, 1903. No. 59355 A.

Electro-Metallurgy.

Practical Notes on the Electro-Depositing of Copper on Iron, Carbon and Zinc. Sherard Cowper-Coles. A review of apparatus and methods used and applications made. Ill. 6500 w. Elec-Chem and Met—Nov., 1903. No. 59649 E.

Industrial Applications.

Industrial Electrochemistry and Electrometallurgy. John B. C. Kershaw. The first section of a second series of notes dealing with recent progress in the industrial application of electro-chemical and electrometallurgical processes. 3700 w. Elec Rev, N. Y.—Dec. 5, 1903. Serial. 1st part. No. 59467.

Ozone.

The Production and Uses of Ozone. Illustrates and describes the more important forms of ozoniser which have been devised for the production of ozone in the air by means of the silent electric discharge, comparing the figures for their yield, and giving information concerning the earlier attempts made in Europe to apply this ozonised air to water purification. 3000 w. Engr, Lond—Nov. 20, 1903. No. 59351 A.

See also Civil Engineering, Water Supply.

Sodium.

The Sodium Industry in France. P. Letheule. An explanation of the electrolytic and electrochemic processes of H. Becker. 2000 w. Elec-Chem Ind—Dec., 1903. No. 59515 C.

ELECTRO-PHYSICS.

Air Electrifying.

Means for Electrifying the Atmosphere on a Large Scale. Sir Oliver Lodge, before the Physical Society. Outlines the method of discharging electricity into the air in times of fog, describing some effects. 1500 w. Elect'n, Lond—Nov. 20, 1903. No. 59356 A.

Alternating Currents.

Alternating Current Principles. George T. Hanchett. Explanatory notes. 2800 w. Cent Sta—Dec., 1903. No. 59601.

Condenser.

The Electrodynamic Condenser (Der Elektrodynamische Kondensator). J. Seidener. A discussion of the electrodynamic condenser of Leblanc and Swinburne as compared with the ordinary electrostatic condenser. 2000 w. Zeitschr f Elektrotech—Nov. 22, 1903. No. 59866 D.

Conductivity.

Tests of Steel for Electric Conductivity, with Special Reference to Conductor-Rails. J. A. Capp. Reports a series of tests made by the General Electric Co. on a wide range of steels, with a study of the results. 2800 w. Trans Am Inst of Min Engs—Oct., 1903. No. 59535.

Eddy Currents.

Experiments on Eddy Currents. W. M. Thornton. An account of experiments on cast iron and steel rings, tests on continuous and alternate current machines, magnetic field disturbance, &c. 6000 w. Elec Engr, Lond—Dec. 18, 1903. No. 59766 A.

Electric Convection.

Electric Convection—A Historical Summary with a Bibliography. J. Frank Meyer. 2500 w. Jour Fr Inst—Dec., 1903. No. 59552 D.

Electrons.

Electrous and Atmospheric Electricity. Discusses the value of the theory of electrons in determining weather probabilities and atmospheric changes. 2000 w. Elec Rev, Lond—Nov. 20, 1903. No. 59359 A.

Maximum Current.

Grouping of Cells to Obtain Maximum Current. Dr. K. E. Guthe. Discussion of this subject, outlining the method of solving a stated problem. 900 w. Elec Wld & Engr—Dec. 12, 1903. No. 59610.

Mercury Vapor.

Conductivity of Mercury Vapor. Peter Cooper Hewitt. Reports an investigation into the behavior of the mercury vapor and the results. Also editorial. 2200 w. Elec Rev, N. Y.—Dec. 19, 1903. No. 59678.

Radio-Activity.

Experiments in Radioactivity. H. Stanley Allen. Read before the Royal Philosophical Soc. of Glasgow. An account of facts observed and experiments carried out, showing some of the properties, with an outline of the history and preparation of radium. 4700 w. Engng—Dec. 4, 1903. No. 59640 A.

Radio-Active Substances. Mme. Sklodowska Curie—Condensed by Dr. J. Ohly. A report of the researches of Mme. Curie. 1500 w. Min Rept—Nov. 26, 1903. Serial. 1st part. No. 59334.

Radium and Radio-activity. Madame Sklodowska Curie. An account of the discovery of this substance, and its properties. 3800 w. Century Mag—Jan., 1904. No. 59901 D.

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The New Element Radium. Ernest Merritt. An explanation of radioactivity, and account of investigations which have thus far been made, with report of the discovery of radium and its importance. 5000 w. Century Mag—Jan., 1904. No. 59900 D.

Roentgen Rays.

New Roentgen Ray Apparatus. Illustrated description of outfit. 1400 w. Sci Am Sup—Dec. 5, 1903. No. 59483.

Sun-Spots.

Influences of the Sun-Spots upon Electrical and Magnetic Forces of the Earth. William Finn. An account of investigations, and of theories. 2000 w. Sci Am Sup—Dec. 5, 1903. No. 59484.

Ultra-Violet Light.

Ultra-Violet Light and the Electric Discharge. Walter J. Turney. Describes experiments made. 1000 w. Sci Am Sup—Dec. 5, 1903. No. 59485.

Welding.

Some Notes on the Welding of Aluminum. Sherard Cowper-Coles. Read before the Faraday Soc. An illustrated article reviewing various processes and apparatus, and describing the writer's process and the tests made. 1600 w. Elec-Chem & Met—Nov., 1903. No. 59648 E.

GENERATING STATIONS.

Armatures.

The Best Dimensions for Armature Slots in Continuous-Current Dynamos (Ueber die Günstige Dimensionierung der Nuten von Gleichstromankern). A. Müller. A mathematical investigation, showing the best ratio the thickness of tooth to width of slot to be about 0.6. 1500 w. Zeitschr f Elektrotech—Nov. 29, 1903. No. 59868 D.

Central Station.

Reconstructed and enlarged Central Station. An illustrated description of the reconstructed plant of the Meriden Electric Light Company. 5000 w. Am Elect'n—Dec. 1903. No. 59413.

The Combined Use of Alternating and Direct Current for Central Station Work. Prof. F. C. Caldwell discusses various phases of the problem of what proportion of each should be used. 3500 w. Elec Rev, N. Y.—Nov. 28, 1903. No. 59372.

Direct Process.

A New Device for Producing Electrical Currents. Brief illustrated description of of apparatus devised by James H. Reid for producing energy direct from fuel, with editorial notes. 1200 w. Elec Rev, N. Y.—Dec. 12, 1903. No. 59579.

Dynamos.

A New Compounded Three-Phase Generator. Translation of an article by E. Kolben in *Electrotechnische Zeitschrift*. Describes a modification of the Heyland machine. Ill. 1000 w. Elec Engr, Lond Nov. 27, 1903. Serial, 1st part. No. 59432 A.

Continuous-Current Dynamos for Direct Connection with Steam Turbines. (Gleichstrommaschinen in Direkter Kupplung mit Dampf-Turbinen). Maximilian Zinner. Discussing the modifications of the commutator necessary to prevent sparking at high rotative speeds. 2500 w. Zeitsch f Electrotech—Nov. 29, 1903. No. 59867 D.

The Construction of Dynamos in Germany (La Construction des Dynamos en Allemagne). C. F. Guilbert. Illustrated description of the products of the principal German builders. Serial. Part I. 2000 w. Revue Technique—Nov. 25, 1903. No. 59828 D.

The Series and Parallel Operation of Generators. F. C. Caldwell. An illustrated discussion of cases. 1200 w. Engr U. S. A.—Dec. 15, 1903. Serial, 1st part. No. 59609 C.

Engine Driving.

See Mechanical Engineering, Steam Engineering.

Exeter Works.

The New Electricitv Works at Exeter. Illustrates and describes a two-phase system. 3300 w. Elect'n, Lond—Dec. 11, 1903. No. 59721 A.

Extensions.

Recent Extensions of the Bradford Corporation Electrical Undertakings. An illustrated description of the developments of the last few years. 1700 w. Elec Rev, Lond—Dec. 18, 1903.. Serial, 1st part No. 59769 A.

Gas Power.

Gas-Power for Central Stations. J. R. Bibbins. On the advantage of operating electric stations in connection with gas works. 4000 w. Trans Am Inst of Elec Engrs—Dec. 18, 1903. No. 59655 D.

Hydro-Electric.

The Hydro-Electric Station at Avignonnet (Usine Hydro-Electrique d'Avignonnet). A. Dumas. An illustrated description of a station on the Drac, Department of Isère, France, where a fall of 23 metres is used to develop 5,590 horse power. Details of the dam and general construction are given. 3000 w. 1 plate. Génie Civil—Nov. 14, 1903. No. 59800 D.

The Lachine Rapids Power House of the Lachine Rapids Hydraulic and Land Company, Limited, Montreal. Illustrated description of this unique plant of low head and large capacity, and its method of operation. 7000 w. Can Soc of Civ

Engrs, Adv. Proof—Dec., 1903. No. 59658 D.

Isolated Plant.

Electric Lighting and Power Plant at the Tooting Bee Asylum. Illustrates and describes a plant having novel features. 1500 w. Elec Engr, Lond—Dec. 18, 1903. No. 59768 A.

Mechanical Stokers.

See Mechanical Engineering, Steam Engineering.

Niagara.

Recent Developments in Niagara Power. H. W. Buck. Illustrates and describes recent plants on both sides of the river. 2300 w. Cassier's Mag—Dec., 1903. No. 59744 B.

Rates.

A Method for Determining Rates and Prices for Electric Power. Frank B. Perry. Gives a method for rearranging a schedule of rates based on the "step-system." 2400 w. Trans Am Soc of Mech Engrs, No. 012—Dec. 1903. No. 59324.

Methods of Charging for Electrical Energy. Ellis H. Crapper. Abstract of a paper read before the Leeds Soc. of the Inst. of Elec. Engrs. Discusses the uniform meter rate, the two-rate meters and other systems. 3200 w. Elect'n, Lond—Dec. 18, 1903. No. 59771 A.

Reversals.

The Reversal of a Large Power Station. L. H. Pike. Describes conditions which led to the necessity of feeding lines in multiple with other stations, and the troubles met and overcome. Diagrams. 1500 w. Eng, U. S. A. Dec. 1, 1903. No. 59371 C.

Small Towns.

Destructor and Electricity Stations in Small Towns. S. D. Schofield. Abstract of a paper read before the Leeds Soc. of the Inst. of Elec. Engrs. Discusses the economy of this combination in the present article, showing the destructor is not a factor in the economical generation of electricity. 1400 w. Elec Engr, Lond—Nov. 27, 1903. Serial, 1st part. No. 59433 A.

South Africa.

Durban (S. Africa) Electric Light and Tramways. An illustrated description of a new combined power station, reviewing also the old works. 1500 w. Elec Rev, London—Dec. 11, 1903. Serial. 1st part. No. 59726 A.

Switchboards.

Switchboard Construction for Isolated Electric Plants. J. E. Woodwell. Describes the usual switchboard construction, calling attention to points of importance, and giving facts concerning the selection of the type of instruments and circuit breakers. 2500 w. Power—Dec., 1903. No. 59499 C.

Synchronizers.

Synchronizers and Parallel Operation of Dynamos. Arthur B. Weeks. On the use of voltmeters as synchronizers, and various cases in paralleling. Also brief illustrated description of the Lincoln synchronizer. 3400 w. Engr, U. S. A.—Dec. 15, 1903. No. 59608 C.

LIGHTING.

Arc Lamps.

Flame Arc Lamps. J. Zeidler. Extracts from a paper before the Electrotechnische Verein of Berlin, describing two forms of lamp. 1200 w. Aust Min Stand—Nov. 5, 1903. No. 59755 B.

Radiation.

Radiation and Illumination. An outline of the modern aspect of radiation and illumination. 4500 w. Engng—Nov. 20, 1903. Serial. 1st part. No. 59344 A.

Spectroscope.

Electric Lighting and a New Spectroscopic Method (Ueber Elektrodisches Leuchten und eine Neue Spektroskopische Methode). Dr. Werner von Bolton. An examination of the light effects produced in connection with the electrolysis of aqueous solutions. 3000 w. Zeitschr f Elektrochemie—Nov. 19, 1903. No. 59864 D.

Street Lighting.

Street Lighting in Berlin. A Comparison Between Electric Arc Lights and High-Pressure Gas-Burners. Translation of a paper read before the German Assn. of Gas and Water Engrs. Results of photometrical observations conducted by Prof. Drehschmidt. Diagrams. 2200 w. Jour Gas Lgt—Dec. 8, 1903. No. 59717 A.

MEASUREMENT.

Ammeter.

Construction of a Magnetic Vane Voltmeter or Ammeter. J. C. Brocksmith. Working drawings with directions. 1200 w. Am Elect'n—Dec., 1903. No. 59417.

Compensation.

Improvements in Compensation Apparatus (Ueber Neuerungen an Kompensations-Apparaten). Dr. Rudolf Franke. Describing varieties of apparatus for measuring a wide range of pressures. 2000 w. Elektrotech Zeitschr—Nov. 26, 1903. No. 59858 B.

Curve Form.

The Influence of the Curve Form on the Application of the Two-Wattmeter Method (Der Einfluss der Kurvenform bei Anwendung der Zweiwattmetermethode). L. Bloch. A discussion of the methods of

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measuring the effectiveness of a polyphase current. 2000 w. Elektrotech Zeitschr—Dec. 3, 1903. No. 59861 B.

Dynamo Testing.

Testing Alternators Under Full Load Conditions. W. L. Waters. Criticisms of method recently discussed by Mr. Behrend, showing the results are unreliable in regard to regulation, and are apt to exaggerate the iron losses to the prejudice of efficiency. Also a letter from Mr. Behrend. 1600 w. Elec Wld & Engr—Nov. 28, 1903. No. 59374.

The Testing of Electric Generators by Air Calorimetry. Richard Threlfall. Read before the Inst. of Elec. Engrs., England. An account of experimental investigations of the writer, and this method of testing. Ill. 8800 w. Elect'n, Lond—Nov. 27, 1903. No. 59436 A.

The Testing of Electric Generators by Air Calorimetry. Abstract of the discussion of paper by Prof. R. Threlfall, with editorial. 3500 w. Elect'n, Lond—Dec. 4, 1903. No. 59623 A.

Form Factor.

Measurement of the Form Factor of an Alternating Current. (Die Messung des Formfaktors einer Wechselspannung). P. Rose and A. Kühns. An examination of the relation of the effective to the mean pressure in alternating currents. 2000 w. Elektrotech Zeitschr—Dec. 3, 1903. No. 59860 B.

Meters.

Meter Connections for Three-Wire Systems (Zählerschaltungen für Drehstromnetze mit Nullleiter). Georg Stern. A comparison of the methods of Aron and of the author for the measurements of efficiency in three-phase systems. 1800 w. Elektrotech Zeitschr—Nov. 26, 1903. No. 59857 B.

Strobograph.

The Slow Registration of Rapid Phenomena by Strobographic Methods. E. Hospitalier. Read before the Inst. of Elec. Engrs. Describes wave-recorder and power-recorder instruments, referring to applications. Ill. 7500 w. Elect'n, Lond—Dec. 11, 1903. No. 59725 A.

Wattmeters.

Making an Integrating Wattmeter. Some points in the construction of the Stanley wattmeters with views of the Stanley Instrument Company's works. 2500 w. Elec Rev N. Y.—Dec. 12 1903. No. 59578.

Rating of Wattmeters for Three-Phase Systems. Charles Brandeis. Gives curves devised by the writer and explains their use. 1000 w. Can Engr—Dec., 1903. No. 59444.

POWER APPLICATIONS.

Agriculture.

The Application of Electricity to Agricultural Machinery (Les Machines Agricoles et l'Agriculture). E. Guarini. With illustrations of practical applications of electric motors to various agricultural operations. 3000 w. Rev Gen des Sciences—Nov. 30, 1903. No. 59835 D.

Charging Machine.

Improved Machinery for Charging Open Hearth Furnaces (Neuere Chargiermaschine zur Beschickung der Herdöfen in Hüttenwerken). W. Küppers. Describing improved electrically operated machines designed in Germany for operating in connection with overhead travelling cranes. 2500 w. Elekt otech Zeitschr—Dec. 3, 1903. No. 59859 B.

Cranes.

Modern Cranes (Neuere Krane). A. Müller. Illustrating and describing locomotive, bridge and gantry cranes, operated by electric power, recently installed in important workshops in Germany. 2000 w. Zeitschr d Ver Deutscher Ing—Nov. 28, 1903. No. 59813 D.

Electric Vehicles.

See Mechanical Engineering, Automobiles.

Escalator.

Electric Traveling Incline (Rampe Mobile Electrique). René Weil. A description of the double incline escalator between the beach and the bluffs at the watering place of Biarritz, France. 1800 w. 1 plate. Génie Civil—Dec. 12, 1903. No. 59809 D.

Glass Making.

Power Equipment in a Bottle-Making Plant. R. M. Hopkins. Describes the plant and processes used by the Illinois Glass Co., of Alton, Ill., and explains the electrical system employed, the apparatus installed, and the general arrangement of the power plant and transmission system. 2500 w. Eng. Rec—Dec. 12, 1903. No. 59598.

Induction Motors.

The Choice of the Rotor Diameter of Induction Motors. Translation of an article by H. M. Hobart in *Elektrotechnische Zeitschrift*. Emphasizes the importance of that part of the total inductance, which is due to the end connections, and develops a practical method by which the best dimensions may be decided. 1200 w. Elec Engr, Lond—Dec. 11, 1903. No. 59720 A.

Loading.

Load Equalization for Asynchronous Motors (Belastungsausgleich von Asynchronmotoren für Stossweise Betriebe).

Hans Linsenmann. An examination of the influence of irregular loading, developing curves for computation of turning moments, and regulating masses. 2500 w. Elektrotech Zeitschr—Nov. 19, 1903. No. 59853 B.

Machine Driving.

Power for Large Machine Tools. Charles H. Benjamin. An illustrated report of a series of measurements made by the senior students of Case School of Applied Science on electrically-driven machines in two large modern shops. 1500 w. Cassier's Mag—Dec., 1903. No. 59747 B.

Mining Power.

A Central Electric Power Plant of the Coal-Mining Department of the Delaware, Lackawanna & Western Railroad Co. at Scranton. H. M. Warren. Illustrated detailed description. 3300 w. Mines & Min—Dec., 1903. No. 59384 C.

Power Consumption for Mining Machinery (Kraftbedarf von Bergwerksmaschinen). H. Huber. Data and results of tests of electrically driven mining machinery, with fac-simile reproductions of the records of the registering apparatus. 2500 w. 11 plates. Glückauf—Dec. 12, 1903. No. 59850 D.

The Plant of the Richard Mine at Brüx (Die Neue Anlage Richard-Schacht in Brüx). Paul Sonntag. A very complete description of the electric power plant installed in an important coal mine in Northwestern Bohemia. Three articles, 7500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Nov. 21, 28, Dec. 5. 1903. No. 59852, each D.

Motor Diagrams.

A Graphical Development of the Ossanna Diagram (Graphische Ermittelung des Ossannaschen Diagrammes). Ad. Thomälen. A comparison of the Ossanna and the Heyland diagrams for induction-motor computations. 4000 w. Elektrotech Zeitschr—Nov. 26, 1903. No. 59856 B.

Peat-Coal.

Peat-Coal by Electrical Process. Description of the apparatus employed and its method of operation, as used by a firm in England. Claims to convert peat into firm, smokeless steam coal at small cost. 800 w. U S Cons Repts, No. 1824—Dec. 12, 1903. No. 59551 D.

Pumps.

Electrically Driven Well Pumps. Illustrated description of a plant installed in London to pump a private well. 1200 w. Engr, Lond—Dec. 18, 1903. No. 59780 A.

Single-Phase.

A Single-Phase Motor. Illustrated description of the motor employed in the new system of single-phase traction introduced by the Union Elektricitäts Gesellschaft. 3000 w. Elect'n, Lond—Nov. 27, 1903. No. 59437 A.

European Single-Phase Railway Motor. Guido Semenza. An illustrated account of experiments with the motor designed by Giorgio Finzi. 3000 w. St Ry Jour—Dec. 12, 1903. No. 59584 C.

Self-Starting Single-Phase Motor without Commutator (Mit-Last Angehender Kollektorloser Einphasen-Wechselstrommotor). Dr. Max Corsepius. Describing a simple form of single-phase motor. 2500 w. Elektrotech Zeitschr—Dec. 10, 1903. No 59863 B.

The Finzi Single-Phase, Alternating-Current Traction Motor. Enrico Bignami. Illustrated detailed description. 2000 w. Elec Rev, N. Y.—Dec. 12, 1903. No. 59580.

Speed Control.

Speed Variation of Continuous-Current-Motors by Shunt-Control. H. M. Hobart. Reviews recent articles relating to methods of speed control, criticising statements made and explaining principles that need attention. 2500 w. Elec Rev, Lond—Dec. 4, 1903. No. 59622 A.

Vibrations.

Methods of Overcoming the Vibrations Caused by Motors. Sherard Cowper-Coles. Illustrations with brief notes on a method of placing or suspending the motors on springs which has been found satisfactory. 300 w. Elec Chem & Met—Nov., 1903. No. 59650 E.

TRANSMISSION.

Transformers.

Some Notes on the Theory and Working of Transformers. W. Rogers. Considers the fundamental principles of the alternate-current transformer and important phenomena met with in the working. 2400 w. Elec Engr, Lond—Dec. 18, 1903. Serial, 1st part. No. 59767 A.

MISCELLANY.

Designing.

The Design of Direct-Current Machinery. Val. A. Fynn. Confined particularly to the smaller machines, discussing points in design, etc. Ill. 1800 w. Elec Rev, Lond—Nov. 20, 1903. Serial, 1st part. No. 59358 A.

Education.

The Education of an Electrical Engineer. Prof. F. G. Baily. Abstract of a paper read before the Glasgow Local Soc. of the Inst. of Elec. Engineers. Outlining a scheme of education. 1200 w. Elect'n, Lond—Dec. 11, 1903. No. 59724 A.

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England.

Some Hindrances to the Development of the Electrical Manufacturing Industry in this country. E. W. Cowan. Chairman's address to Manchester Local Section of the Inst. of Electrical Engineers. Abstract. 3300 w. Elect'n, Lond—Nov. 20, 1903. No. 59357 A.

Gilbert.

Gilbert of Colchester, Father of Electrical Science. A reprint of part of the Chapter on Electrics from *De Magnete*, Lib. II., with notes by Silvanus P. Thompson. Also an account of the Gilbert tercentenary commemoration. 9000 w. Elect'n, Lond—Dec. 11, 1903. No. 59723 A.

Siberia.

Electricity in Siberia. Illustrated article describing electrical installations seen by an American traveler. 1600 w. Elec Rev, N. Y.—Dec. 12, 1903. No. 59581.

GAS WORKS ENGINEERING

Combustion Products.

Combustion Products of Gas and Oil Stoves. Particulars of the experiments made by Dr. Thorpe designed to ascertain the effects of burning gas and oil in heating stoves. Also editorial. 3000 w. Jour of Gas Lgt—Nov. 24, 1903. No. 59421 A.

Enrichment.

The Policy of Gas Enrichment (Illustrated by London Practice). Discussion at Detroit, Mich., of the paper of Arthur Graham, Glasgow. 4000 w. Am Gas Lgt Jour—Dec. 14, 1903. No. 59582.

Eruptions.

Gases Generated Within the Earth by Oils Occasionally Create Eruptions. Relates some instances that have been observed. Ill. 1000 w. Am Gas Lgt Jour—Nov. 30, 1903. No. 59364.

Explosions.

Experiments in Gas Explosions. L. Bairstow. Read before the British Ass'n. An account of experimental investigations. 1600 w. Mech Engr—Nov. 21, 1903. No. 59362 A.

Firing.

Notes on Gaseous Firing. J. F. Smith. Read before the Yorkshire Jr. Gas Assn. An illustrated article giving a historical summary and explainng the changes that go on in the gas producer, the principle and theory of gaseous firing, and the practical working. 7000 w. Jour Gas Lgt—Dec. 15, 1903. No. 59753 A.

Flow.

Flow of Gas in Long Pipes and Under High Pressures. An explanation by H. A. Humphrey for working out the formula for the calculation of the isothermal flow of gas in long pipes. 700 w. Jour of Gas Lgt—Nov. 24, 1903. No. 59420 A.

Gas.

Gas. Thomas D. Miller. An illustrated historical review of the manufacture and development of the gas industry, especially describing the business in New Orleans, which was the second gas works built in the United States. 5300 w. Jour Assn of Engng Soc's—Oct., 1903. No. 59574 C.

Gas Engines.

See Mechanical Engineering, Special Motors.

Gasholders.

Rules for the Specification of the Ironwork of Gasholders. The substance of two documents promulgated by a joint committee of the German Gas Assn. and the Union of German Gasholder Makers, with a view of establishing a uniformity of practice. Also editorial. 4600 w. Gas Wld—Nov. 28, 1903. No. 59429 A.

Gas Producers.

Apparatus for Converting Fuel into Heating or Power Gas (Ein Verfahren zur Umsetzung der Brennstoffe in Heiz oder Kraftgas). H. Jahns. Describing an arrangement of gas producers in series, with a corresponding increase in efficiency. 2000 w. Glückauf—Dec. 5, 1903. No. 59849 D.

Gas Engines and Gas Producers (Gazogène et Moteurs à Gaz). A description of the installation of Taylor gas producers and engines at the generating station at Etampes. 1000 w. Génie Civil—Dec. 5, 1903. No. 59807 D.

Improved Down-Draft Gas Producer (Nouveau Gazogène à Flamme Renversée). Jules Deschamps. Describing experiments with a reversed draft producer adapted for by-product recovery, and for use with gas engines. 4000 w. Mem Soc Ing Civ de France—Sept., 1903. No. 59875 G.

Mond Gas-Driven Rolling Mills and Power Plant at the Works of Messrs. Monks, Hall & Co., Ltd., Warrington. Illustrated detailed description of gas plant for supplying power to large works. 3200 w. Ir & Coal Trds Rev—Nov. 27, 1903. No. 59511 A.

New Gas-Producing Plants. Illustrations and descriptions of improved pro-

ducer gas plants designed by a firm of Manchester, Eng. 2000 w. Engr, Lond—Dec. 11, 1903. No. 59741 A.

Pierson's "Suction" Gas-Producer. An illustrated detailed description of this producer and its action, with a statement of the claims made. 1500 w. Engng—Nov. 20, 1903. No. 59346 A.

Producer Gas in Tramway Service. Illustrates and describes an electric tramway, the current for which is supplied from a generating station driven by power gas. 1500 w. Trac & Trans—Dec., 1903. No. 59632 E.

Gas Works.

New Gas-Works at Shrewsbury. Illustrates and describes features of interest. 2300 w. Gas Wld—Dec. 12, 1903. No. 59714 A.

Some Features of Gas Making and Gas Lighting at Elland. An illustrated article describing progress and improvements. 3400 w. Gas Wld—Dec. 19, 1903. No. 59765 A.

Incandescent Lighting.

Incandescent Street-Lighting. J. F. Tyndall. Read before the South-East of Ireland Gas Assn. A short paper giving the writer's experience, with discussion. 2500 w. Gas Wld—Dec. 5, 1903. No. 59618 A.

I. Why Corporations and Companies Should Undertake Internal Fitting Work. A. E. Mottram. II. Incandescent Lighting and Maintenance. S. Meunier. Also discussion. Two papers read before the Manchester Dist. Inst. of Gas Engrs, and discussed together. 1500 w. Jour Gas Lgt—Dec 1, 1903. No. 59518 A.

Retort Charging.

From Orwell to Coke Heap or Wagon. An illustrated description of West's combined charging and drawing machine, recently installed at Ipswich. Also the coke-conveying plant. 5000 w. Jour Gas Lgt—Dec. 1, 1903. No. 59517 A.

Roofs.

Iron Roofs for Gas-Works. Norton H. Humphrys. An illustrated article describing the treatment given to iron roofing, and the advantages of this form of structure. 2000 w. Jour Gas Lgt—Dec. 8, 1903. No. 59715 A.

Subways.

Subway Systems. R. M. Parkinson. Extracts from the first prize essay in the competition on this subject instituted by the Paviours' Company. Ill. 2600 w. Jour Gas Lgt—Dec. 1, 1903. No. 59519 A.

Transmission.

Gas-Pipe v. Copper—A Defense. C. Alfred Smith. A reply to an article by E. Kilburn Scott, written in criticism of a previous paper by Mr. Smith. 2000 w. Elec Rev, Lond—Dec. 4, 1903. No. 59621 A.

Tynemouth.

Tynemouth Gas-Works, North Shields. A. Clement Hovey. Constructional details and costs of recent extensions (1900-1902), with notes on working results. 11200 w. Gas Engrs' Mag—Nov. 10, 1903. No. 59312 A.

INDUSTRIAL ECONOMY

Address.

The Money Value of Technical Training. James M. Dodge. President's address at meeting of the A. S. M. E. Also editorial. 5000 w. Eng Rec—Dec. 5, 1903. No. 59477.

Apprentices.

An Example of Modern Development of the Apprenticeship System. L. D. Burlingame. Describing the system in successful operation in the shops of the Brown & Sharpe Mfg. Co., at Providence. 3500 w. Engineering Magazine—Jan., 1903. No. 59885 B.

British Revenue.

The Fiscal Problem. Sir Charles Malcolm Kennedy. Traces the adoption of the present fiscal policy and tariff of the United Kingdom, the principal European powers, and the United States; explaining the present commercial, industrial and economic position of these powers, and referring to details related. General discussion. 24000 w. Jour Soc of Arts—Dec. 4, 1903. No. 59633 E.

Commerce.

The Evolution of the Commerce of the World (L'Evolution du Commerce du Monde). M. Bichon. A study of the influence of scientific discovery upon the development of commerce in the nineteenth century. 6000 w. Rev Gen des Sciences—Dec. 15, 1903. No. 59836 D.

Conciliation Board.

A Great Experiment: The Anthracite Conciliation Board. The present article reviews the history of the appointment of this board by the Arbitration Commission, stating its duties. 1500 w. Eng & Min Jour—Dec. 24, 1903. No. 59910.

Education.

A Visit to English and Continental Engineering Schools and Commercial Estab-

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lishments. Forrest Jones. A report of information gained during seven months spent in visiting foreign educational institutions. 7200 w. Sib Jour of Engng—Dec., 1903. No. 59789 C.

University Education and the Education of the Engineer. William Kent. An interesting discussion of education and its aims, and the writer's views on the best way to educate an engineer. 4500 w. Sib Jour of Engng—Dec., 1903. No. 59790 C.

Labor.

The Open Shop. T. F. Woodlock. Address before the Nat. Civic Fed. in Chicago. Discusses the case of the public in favor of the open shop. 2000 w. Ry Age—Dec. 11, 1903. No. 59593.

The Position of Organized Labor. Samuel Gompers. The second of a series of articles by representatives of both sides of the controversy between labor and capital. 7800 w. Bankers' Mag, N. Y.—Dec., 1903. No. 59554 D.

Miners.

The Condition of Miners in the Ruhr District (Die Lage der Bergarbeiter im Ruhrrevier). A review of the book of Dr. Pieper, showing the wages, cost of living, and general condition of the miners in the coal mining district of the Ruhr. 2500 w. Glückauf—Nov. 28, 1903. No. 59-847 D.

Panama.

Payments on Account of the Panama Canal. A discussion of the financial side of this great undertaking. 1600 w. Bankers' Mag, N. Y.—Dec., 1903. No. 59553 D.

Piece Work.

Is Anything the Matter with Piece Work? Frank Richards. A discussion of the merits of "piece work" and of the "premium plan." 2000 w. Trans Am Soc of Mech Engrs No. 01.—Dec., 1903. No. 59315.

Premium System.

The Premium System in Practice. Charles B. Cook. An explanation of the system as used in a factory. 1700 w. Ir Trd Rev—Dec. 3, 1903. No. 59449.

Profit-Sharing.

Profit Sharing and the Premium Plan. Kenneth Falconer. Gives a suggested plan of profit-sharing based on the principles of the premium plan of paying wages. 1800 w. Cassier's Mag.—Dec., 1903. No. 59749 B.

Steel Trade.

The Theory and Practice of Dumping. The first of a series of articles on the dumping of foreign iron and steel in British markets. 4000 w. Ir & Coal Trds Rev—Nov. 27, 1903. Serial. 1st part. No. 59513 A.

Trusts.

The Future of the Trusts. Editorial on the recent changes in the administration of the great industries of the country, reviewing the development of American railways as a close parallel. 1700 w. R R Gaz—Dec. 25, 1903. No. 59924.

MARINE AND NAVAL ENGINEERING

Battleship.

U. S. Battleship Missouri. Lieut.-Com. F. C. Bieg. Description of the vessel, giving report of official trial performance, and illustrations of boiler. 7500 w. Jour Am Soc of Nav Engrs—Nov., 1903. No. 59-571 H.

Boilers.

See Mechanical Engineering, Steam Engineering.

Bulkhead Door.

The Stone-Lloyd Bulkhead Door. An illustrated description of an extremely ingenious mechanism, fitted to the imperial mail steamer Deutschland. 1200 w. Engr, Lond—Dec. 4, 1903. No. 59644 A.

Coaling.

Coaling at Sea. A. C. Cunningham. An illustrated description of the Cunningham-Seaton proposed method. 1600 w. Jour Am Soc of Nav Engrs—Nov., 1903. No. 59564 H.

Dry-Docks.

Havana Floating Dry-Dock. Now at Navy Yard, Pensacola, Florida. An illustrated description of this dry-dock with an outline of its eventful history. 1100 w. Marine Engng—Dec., 1903. No. 59506 C.

The Concrete Dry-Dock at Kiel, Germany: Subaqueous Construction by Floating Pneumatic Caisson. An illustrated description of interesting construction work, a new plan being devised to meet the peculiar conditions. The central feature of the work is the use of what is in effect a huge diving bell. 6000 w. Eng News—Dec. 3, 1903. No. 59487.

The U. S. Steel Floating Dry-Dock for Cavite, Philippine Islands. J. S. Shultz. Illustrations showing the characteristic features, with explanation of the method of self-docking. 2000 w. Eng News—Dec. 10, 1903. No. 59525.

Ferryboat.

The Oil-Burning Ferryboat Kamona.

An illustrated detailed description of a fire boat to be used in the harbor of San Diego. 2500 w. Marine Engng.—Dec., 1903. No. 59508 C.

Fire-Boat.

New York City Fire-Boat Abram S. Hewitt. Illustrated detailed description. 2400 w. Naut Gaz—Dec. 10, 1903. No. 59600.

Liner.

The New White Star Liner Baltic. Illustration, with brief description. 500 w. Engr, Lond—Nov. 27, 1903. No. 59427 A.

Marine Engines.

Four-Crank Quadruple-Expansion Engine (Macchine a Quadruplice Espansione con Quattro Manovelle). Salvatore Orlando. A description of the construction and trials of the quadruple-expansion engines of the steamship Umbria, of the *Navegazione Generale Italiana.* 10000 w. 6 plates. Rivista Marittima.—July, 1903. No. 59870 H.

Investigation of the Stresses on Frames of Vertical Steam Engines—As Modified for Marine Engines. John H. Meyer. Mathematical investigations of stresses due to the rolling and pitching of the vessel. 11000 w. Jour Am Soc of Nav Engrs—Nov., 1903. No. 59562 H.

Melville.

Rear-Admiral G. W. Melville, U. S. N., and Applied Science in Construction of the New Fleet. R. H. Thurston. On the influence of Admiral Melville in the creation of the "new navy." 1700 w. Pop Sci M—Dec., 1903. No. 59310 C.

Motor Boats.

Motor Vehicles of the Waterways. Illustrates some of these motor boats, calling attention to points in the construction. 1700 w. Automobile—Dec. 12, 1903. No. 59603.

Nile Boats.

The Passenger Boat Service on the Nile. A résumé of the service carried on, with a sketch of the very earliest and the latest type of boat used. 4000 w. Engr, Lond—Nov. 27, 1903. No. 59424 A.

Petrol Launch.

The Racing Petrol Launch "Durendal." Illustrated description of the boat and her performance. 1500. Auto Jour—Dec. 12, 1903. No. 59712 A.

Propellers.

Direction of Rotation of Screw Propellers (Intorno al Senso della Rotazione dell Eliche). Nino Pecoraro. A discussion of trials in the Italian navy concerning the influence of direction of rotation of propellers on the speed of twin-screw vessels. 8000 w. 6 plates. Rivista Marittima—Aug.-Sept., 1903. No. 59872 H.

Direction of Rotation of Propellers. Nino Pecoraro. Trans from *Revista Marittima.* A report of experimental investigations of propulsive efficiency, discussing also the experiments of R. E. Froude. 7500 w. Jour Am Soc of Nav Engrs—Nov., 1903. No. 59566 H.

Note on the Direction of Rotation of Propellers on Twin-Screw War Vessels. M. Laubeuf. Trans. from *Bulletin de L'Association Technique Maritime.* A discussion of the most efficient arrangement. 2700 w. Jour Am Soc of Nav Engrs—Nov., 1903. No. 59570 H.

Schooner Equipment.

The Steam Equipment of a Modern Schooner. An illustrated description of the auxiliary steam appliances, comprising a boiler used for power and heating purposes, steam winches, for anchor sail, and cargo hoisting, and an outfit of pumps, etc. 1800 w. Mach, N. Y.—Dec., 1903. No. 59407 C.

Shipbuilding.

The Progress of Shipbuilding. Editorial review of the address of Sir William White. 4500 w. Engng—Nov. 20, 1903. No. 59347 A.

Steamer.

A Sectional Steamer for Our Colonial Possessions. Illustrates and describes a vessel of novel construction, designed to meet special requirements. 900 w. Sci Am—Dec. 19, 1903. No. 59708.

The Tyne General Ferry Co.'s Twin-Screw Passenger Steamer "Mona." Brief illustrated description. 700 w. Engng—Dec. 18, 1903. No. 59774 A.

The U. S. S. Cleveland. F. C. Bowers. General description, with illustrations and report of official trial. 10800 w. Jour Am Soc of Nav Engrs—Nov., 1903. No. 59567 H.

Submarine.

The Development of the Submarine in the Direction of Increased Scope. Lieut. John Halligan, Jr. A study of the lake submarine torpedo boat "Protector," with illustrations. 10500 w. Jour Am Soc of Nav Engrs—Nov., 1903. No. 59572 H.

The Submarine Boat "Protector." Illustrated description of this American vessel, and information respecting it. 2000 w. Engr, Lond—Nov. 20, 1903. No. 59352 A.

Turbine Engines.

Report Concerning the Design, Installation, and Operation of the Turbine Engines of S. S. Revolution. Also, Report of Board to Observe and Report Concerning the Efficiency of Turbine Engines. Ill. 4000 w. Jour Am Soc of Nav Engrs—Nov., 1903. No. 59573 H.

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Warships.

The British Admiralty and Warship Design. Editorial discussion of the Libertad and Constitucion, designed for the Chilian Navy, but recently purchased by the British Admiralty. 2800 w. Engng—Dec. 11, 1903. No. 59735 A.

The Work of the Oregon During the Spanish-American War. Lieut. C. N. Offley. Reviews the work done below the protective deck during the journey of 14,000 miles, showing the importance of maintaining the motive machinery of battleships in the highest state of efficiency. 7000 w. Jour Am Soc of Nav Engrs—Nov., 1903. No. 59568 H.

MECHANICAL ENGINEERING

AUTOMOBILES.

Accumulator.

The Edison Accumulator for Automobiles. W. Hibbert. Read before the Inst. of Elec. Engrs., England. A favorable report, describing results of observation and experiments. Ill. 6500 w. Elect'n, Lond—Nov. 27, 1903. No. 59434 A.

The Edison Storage Battery (L'Accumulateur Edison). P. Janet. A very complete account of the tests which have been made of the Edison alkaline battery at the *Laboratoire Central d'Electricite* in Paris. 10000 w. Bull Soc Int des Electriciens—Nov., 1903. No. 59873 F.

Alcohol.

See Mechanical Engineering, Special Motors.

British Motors.

Automobiles and Motor Boats. Extracts from an address by S. F. Edge on the conditions and prospects of the British automobile industry, outlining an interesting project in regard to motor boats. 3500 w. U S Cons Repts, No. 1829—Dec. 18, 1903. No. 59656 D.

Care.

How to Keep a Car in Idleness. Directions for the cleaning and care of a car which is to be out of use for several months. 1500 w. Automobile—Nov. 28, 1903. No. 59340.

Construction.

Developments in Automobile Construction. Thomas Clarkson. Read before the British Assn. Discusses details, especially in cars for express or passenger service, the various types of motor and their advantages, etc. Ill. 7500 w. Engng—Dec. 18, 1903. No. 59776 A.

Cycle Shows.

The Annual Cycle Shows.—The National and the Stanley. A brief report of the exhibits, with illustrations. 7000 w. Auto Jour—Nov. 28, 1903. No. 59440 A.

Dust.

The Dust Problem. Col. R. E. Crompton, and C. W. S. Crawley. Excerpt from a paper read before the Automobile Club. Gives facts observed during a test, and conclusions reached. 3000 w. Auto Jour—Dec. 5, 1903. No. 59614 A.

Four-Cylinder Car.

The New Four Cylinder Toledo Car. Illustrated description of a 1904 model gasoline touring car. 1800 w. Automobile—Nov. 28, 1903. No. 59341.

Hoods.

Hoods and Canopies. A. J. Wilson. Remarks on the comfort and convenience of these additions to motor vehicles, illustrating some designs. 1800 w. Autocar—Dec. 5, 1903. No. 59612 A.

Motor Car.

The "Gladiator" Motor Car. An illustrated description of the mechanism of this car. 1200 w. Prac Engr—Nov. 27, 1903. No. 59442 A.

Packard Car.

Packard "Model L" Four-Cylinder Car. Illustrated detailed description of a vertical, four-cylinder motor vehicle of entirely new design. 1500 w. Automobile—Dec. 5, 1903. No. 59462.

Paris Show.

Motor Cars in Paris. Illustrates and describes interesting cars on exhibition at the sixth annual exhibition. 2700 w. Engr, Lond—Dec. 18, 1903. Serial. 1st part. No. 59779 A.

The Paris Autocar Show. Preliminary description, with illustrations. 5700 w. Autocar—Dec. 12, 1903. No. 59713 A.

The Paris Autocar Show. An illustrated article giving a general description of the cars and accessories. 14000 w. Autocar—Dec. 19, 1903. No. 59761 A.

Petrol Cars.

The F. I. A. T. Petrol Cars. An illustrated description of these Italian vehicles. 2500 w. Auto Jour—Dec. 5, 1903. No. 59613 A.

The 24-H. P. Bollée Petrol Car. Illustrated detailed description of as nearly a noiseless vehicle as can be expected of

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one self-propelled. 1700 w. Auto Jour —Dec. 12, 1903. Serial. 1st part. No. 59711 A.

The Vauxhall Light Petrol Car. Illustrated description of an English vehicle, intended to be sold at a moderate price. Of simple construction. 4200 w. Auto Jour—Nov. 21, 1903. Serial. 1st part. No. 59342 A.

Small Engines.

Steam Autocar Notes: Small Steam Engines. J. S. V. Bickford. An illustrated description of experimental designs of the writer, their defects, and difficulties. 4600 w. Engr, Lond—Dec. 4, 1903. No. 59642 A.

Speed Indicator.

The Controller Speed Indicator (Le Controleur Indicateur de Vitesse). J. A. Montpelier. Describing a device for indicating continually the speed of an automobile. 1500 w. L'Electricien—Oct. 31, 1903. No. 59877 B.

Steam Omnibus.

Steam Omnibus for Torquay. Illustrates and describes a steam propelled vehicle for public service. 1000 w. Engr, Lond—Dec. 18, 1903. No. 59783 A.

Tractor.

Military Tractor. An illustrated description of the engine which secured the prize of £1,000 offered by the War-office of England. 2000 w. Engr, Lond—Dec. 18, 1903. No. 59782 A.

Tractor Truck.

Mail Delivery by Tractor Truck, with Use of Old Rolling Stock. Illustrated description of the system of motor traction which is having an eighteen months' test in Philadelphia. 800 w. Automobile —Dec. 19, 1903. No. 59686.

HYDRAULICS.

Current-Meters.

A New Station for the Rating of Current Meters by the U. S. Geological Survey, at Denver, Colorado. M. C. Hinderlider. An illustrated description of a first-class rating station, where meters of all kinds can be accurately rated and their actions under different conditions tested. 1800 w. Eng Rec—Dec. 19, 1903. No. 59672.

Investigations of the Motion of Current Meters (Untersuchungen über die Umlaufbewegung Hydrometrischer Flügel). Dr. M. Schmidt. A study of the action of flowing water upon current meters of the Woltmann mill type, discussing methods of calibration. Two articles. 6000 w. Zeitschr d Ver Deutscher Ing—Nov. 21, Dec. 5, 1903. No. 59811 each D.

Electric Pumps.

See Electrical Engineering, Power Applications.

Flow.

See Mechanical Engineering, Measurement.

Hydraulic Plant.

The Hydraulic Plant for Drawing Steel Shells, at the Imperial Arsenal, Osaka, Japan. Gompei Kuwada. Description of the plant and its equipment. Plan of drawing press. 2000 w. Eng Rec—Nov. 28, 1903. No. 59376.

Pelton Wheels.

The Pelton Wheel for Rolling Mills. Illustrates and describes a remarkable experimental and completely successful departure in rolling-mill practice in a tin mill at Cwm Avon, South Wales. 2500 w. Engr, Lond—Dec. 4, 1903. No. 59643 A.

Pumps.

Air-Lift Pumps. Extracts from a paper by L. Darapsky, on "The Application of Compressed Air to the Raising of Water," published in *Berg und Hüttenmännischen Zeitung*, giving information concerning the history and progress of the air-lift system. Ill. 3500 w. Engr, Lond —Dec. 11, 1903. No. 59,739 A.

Experiments on the Efficiency of Centrifugal Pumps. Thomas E. Stanton. Reviews previous experimental work and describes the apparatus used and experiments made, stating the conclusions reached. Ill. 4800 w. Inst of Mech Engrs—Nov. 20, 1903. No. 59314 D.

Water-Powers.

The Development of Small Water-Powers. Louis Bell. Discusses how to utilize to advantage powers not exceeding 500 h. p. in the water. 3800 w. Am Elect'n—Dec., 1903. No. 59414.

MACHINE WORKS AND FOUNDRIES.

Bearings.

Making a Roller Bearing. Describes new features of construction recently made and the methods of manufacture. Ill. 2700 w. Am Mach—Dec. 3, 1903. No. 59451.

Brakes.

Band Brakes. J. S. V. Bickford. An explanation of what a double-acting band brake is, considering types. Ill. 1400 w. Engr, Lond—Nov. 27, 1903. No. 59425 A.

Brass Furnaces.

Iron Tops for Brass Furnaces. Walter J. May. Suggestions for an improved appliance. Ill. 400 w. Prac Engr—Dec. 18, 1903. No. 59763 A.

Cast Iron.

Malleable Cast Iron. Richard Moldenke. Read at the Milwaukee meeting of the Am. Found. Assn. Discusses the structure, composition, etc., of good mal-

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leable iron. 3700 w. Foundry—Dec., 1903. No. 59546.

Chains.

Chain Making. Illustrates and describes the methods used by the American Chain Cable Works, of Troy, New York. 1700 w. Sci Am—Dec. 12, 1903. No. 59532.

Coke.

Estimating the Value of Coke for Foundry Use. Walter J. May. On the testing of coke, and things to be considered in determining the economy. 1200 w. Prac Engr—Dec. 4, 1903. No. 59616 A.

Coloring.

Metal Coloring. W. J. Kaup. On the treatment of copper, brass, iron, and steel to produce color effects. 2800 w. Mach, N. Y.—Dec., 1903. No. 59406 C.

Cranes.

See Electrical Engineering, Power Applications.

Cupolas.

Some Cupola Practice. R. H. Palmer. Illustrates and describes prevailing practice in the management of cupolas. 1700 w. Foundry—Dec., 1903. No. 59547.

Drawings.

A Modern Drawing Office. Joseph Horner. Considers the requirements, giving hints on the filing of drawings and plans, and discusses the equipment of the pattern shop and allied questions. 2400 w. Page's Mag—Dec., 1903. No. 59751 B.

Systematizing Drawing-Office Standards. The first of a series of articles intended to illustrate a method of organized work when engaged upon a general class of engineering work, especially in that connected with stationary steam engine plants. 1200 w. Prac Engr—Dec. 18, 1903. Serial. 1st part. No. 59762 A.

Truing Up Drawing Instruments. Frank B. Kleinhans. Directions for truing the various instruments. 1500 w. Ir Trd Rev—Dec. 3, 1903. No. 59447.

Drop Hammers.

Tests of Drop Hammers by the Compression of Copper Cylinders. Report of a test by Dr. R. H. Thurston to determine the efficiency of roll and crank lift drop hammers. 1500 w. Am Mach—Dec. 24, 1903. No. 59904.

Electric Driving.

See Electrical Engineering, Power Applications.

Furnaces.

Furnaces Suitable for Jewellers' Work, Enamelling, Art Casting, and Other Similar Industries. H. H. Cunnynghame. Describes briefly furnaces at present in use and their fuels, especially some furnaces recently invented by the writer. Discussion. 6500 w. Jour Soc of Arts—Dec. 11, 1903. No. 59710 A.

Hardening.

Hardening Special Tools. E. R. Markham. Brief description of some methods found to give good results. 1200 w. Am Mach—Dec. 3, 1903. No. 59454.

Lathes.

Heavy Service Lathe. Illustrated description of a lathe for high-speed cutting, with drawings of the gearing. 800 w. Engr, Lond—Nov. 27, 1903. No. 59426 A.

Heavy Turret Lathe. Illustrates and describes a new design of powerful turret lathe recently manufactured in England. It is suitable for screw-cutting, chucking, boring, and general purposes. 2200 w. Engng—Dec. 4, 1903. No. 59638 A.

Machine Tools.

Railroad Shop Tools. Charles H. Fitch. An illustrated article describing recent improvements due to the use of forging presses and dies. 1500 w. Ry Mas Mech—Dec., 1903. No. 59402.

Reciprocating Machine Tools. Illustrations and descriptions of many types. Special supplement. 15600 w. Engr, Lond—Dec. 11, 1903. No. 59740 A.

Speeds and Gearing of Machine Tools. P. V. Vernon. Read before the Manchester Assn. of Engrs. Indicates a method by which the calculations required may be organized with the practical certainty of obtaining the desired sub-division for any given range and number of speeds. 5000 w. Mech Engr—Nov. 21, 1903. No. 59361 A.

What Are the New Machine Tools to Be? John E. Sweet. Considers machine design, and the capabilities of high-speed steel. 1500 w. Trans Am Soc of Mech Engrs, No. 04.—Dec., 1903. No. 59318.

Management.

Modifying Systems of Management. H. L. Gantt. Gives opinions on methods advocated by Mr. Taylor at the Saratoga meeting. 1300 w. Trans Am Soc of Mech Engrs, No. 014—Dec., 1903. No. 59326.

Mechanism.

A New Mechanism. G. T. Bennett. Illustrated description of a skew linkwork of four pieces having the axes of rotation neither parallel nor concurrent. It offers a simple means of communicating rotation immediately between two crossing shafts by the use of a single connecting rod. 2000 w. Engng—Dec. 4, 1903. No. 59639 A.

Patterns.

Pattern Making. Edward C. Fitz Gerald. Read at meeting of Pittsburg Found. Assn. Considers important points in the constructive side of pattern-making, under

the heads of working drawings, selection of material, machining and shaping, assembling and finishing. 2000 w. Ir Age—Dec. 17, 1903. No. 59628.

Pattern Making. J. C. Warne. Read at meeting of Pittsburg Found. Assn. Remarks on wood pattern making, considering materials, machinery, men and patterns. 2700 w. Ir Age—Dec. 17, 1903. No. 59627.

Profiling.

Profiling Fixtures and Formers. C. H. Rowe. Hints regarding fixture design and the cutting of formers. Ill. 1300 w. Am Mach—Dec. 3, 1903. No. 59453.

Punching.

Combined Hydraulic Punching and Shearing Machine. Charles Herzberg. Begins an illustrated, detailed description of a machine built in Austria for the Imperial sea arsenal at Pola. 1800 w. Am Mach—Dec. 17, 1903. Serial. 1st part. No. 59663.

Shaper.

A Shaper Arranged for a Rapid Grooving Operation. Illustration, with brief description. 500 w. Am Mach—Dec. 10, 1903. No. 59510.

Sheet Metal.

The Manufacture of Accurate Sheet Metal Parts in the Sub-Press. Joseph Woodworth. Illustrated description of the sub-press and of the approved methods for constructing dies for it. 1600 w. Ir Trd Rev—Dec. 3, 1903. No. 59448.

Shop Notes.

Making Elevator Buckets with the Steam Hammer—A Special Reaming Machine. S. A. Worcester. Brief illustrated descriptions. 900 w. Am Mach—Dec. 17, 1903. No. 59664.

Shops.

Heating and Ventilating of Foundries and Machine Shops. W. H. Carrier. Abstract of a paper read before the Am. Found. Assn. On the difficulties to be overcome in the successful heating of shops and the adaptation of the fan system. 1800 w. Met Work—Dec. 26, 1903. No. 59793.

Suggestions for Shop Construction. F. A. Scheffler. Describes a novel construction used by the writer. Diagram. 900 w. Trans Am Soc of Mech Engrs, No. 09—Dec., 1903. No. 59321.

See also Railway Engineering. Permanent Way and Buildings.

Steel.

Mistaken Blaming of the Steel. E. R. Markham. Showing that the treatment of the steel, and the proper selection for the purpose, are often at fault. 1200 w. Am Mach—Dec. 3, 1903. No. 59452.

Steel Pipe.

Manufacture of Steel Pipe. An article illustrating and describing the plant and methods of the National Tube Works. 2000 w. Sci Am—Dec. 12, 1903. No. 59530.

Taper Holes.

Taper Holes in Machine Spindles. Frank B. Kleinhans. Illustrates and describes a lathe rigged for performing this operation. 600 w. Am Mach—Dec. 24, 1903. No. 59902.

Taps.

Hardening Taps. E. R. Markham. Gives a description of the method known as pack hardening, as applied to the hardening of taps. 1700 w. Am Mach—Dec. 17, 1903. No. 59667.

Thread Cutting.

Adjustable Die Head and Method for Making Threaders for Use in Same. Joseph M. Stabel. Describes the tools and method used. Ill. 1500 w. Mach, N. Y.—Dec., 1903. No. 59408 C.

Tool Room.

The Modern Tool Room. Fred H. Holz, Jr. Read before the Cincinnati Metal Trds Assn. Suggestions for facilitating work in this department. 1700 w. Ir Trd Rev—Dec. 17, 1903. No. 59685.

Tools.

Tool Making. E. R. Markham. Considers the education of modern successful toolmakers, and discusses cutting speeds, reamers, &c., in the present number. Ill. 4500 w. Mach, N. Y.—Dec., 1903. Serial. 1st part. No. 59404 C.

Tripping Devices.

Trip Hooks and Drop Balls. Ulrich Peters. Illustrated description of tripping devices used in connection with drop weights for breaking up foundry iron, or cracking the skulls from slag ladles, and similar work. 1500 w. Am Mach—Dec. 17, 1903. No. 59665.

Wire and Nails.

Steel Wire and Nail Making. Describes the manufacture as carried on at the Donora Works of the American Steel and Wire Company. Ill. 3000 w. Sci Am—Dec. 12, 1903. No. 59531.

Works.

Modern Work-Shop Design. A. Pringle. The bearing of the class of work upon the design and equipment of shops; the important features, the materials, roofing, &c., are discussed. 5200 w. Can Soc of Civ Engrs, Adv Proof—Dec., 1903. No. 59660 D.

The Works of Messrs. Victor Coates and Co., Limited. Illustrated description. 1600 w. Engng—Dec. 11, 1903. No. 59733 A.

Works' Visits. An illustrated descrip-

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tion of the manufacture of electric cables and the preparation of the insulation in the Warrington factory of the St. Helens Cable Co., Ltd. 3000 w. Elec Engr, Lond —Dec. 4, 1903. Serial. 1st part. No. 59620 A.

MATERIALS OF CONSTRUCTION.

Alloys.

Light Aluminum Alloys. Editorial review of a paper by Dr. Joseph W. Richards, read before the Am. Soc. for Test. Mat., with general discussion of the work of other investigators. 1600 w. Engng—Nov. 20, 1903. No. 59348 A.

Analysis.

Some Troubles with Samples of Iron and Coke. George C. Davis. Read before the Phila. Found. Assn. Considers some of the sources from which disputes may arise, and how to avoid such difficulties. 1500 w. Ir Age—Dec. 17, 1903. No. 59624.

Copper.

Some Applications of Copper in Engineering Practice. W. Ed. Storey. Abstract of a paper read before the Manchester Assn. of Engrs. Discusses the qualities most desirable in engineer's work, studying the structure and considering applications and points that make for utility. 2500 w. Prac Engr—Dec. 18, 1903. No. 59764 A.

Fire-Brick.

An Example of the Alteration of Fire-Brick by Furnace Gases. Frank Firmstone. Gives analysis with particulars. 1500 w. Trans Am Inst of Min Engrs—Oct., 1903. No. 59541.

Tool Steel.

Cutting Speeds and Feeds with the New Tool Steels. Oberlin Smith. A summary of practical experience with high-speed steels in the workshop showing their great advantages. 2500 w. Engineering Magazine—Jan., 1903. No. 59889 B.

The Analysis of High-Speed Steel. A brief résumé of the methods of analyzing high-speed steel. 1000 w. Engr, Lond—Dec. 11, 1903. No. 59737 A.

The Analysis of High-Speed Steels. Suggests methods of analysis. 1500 w. Engng—Nov. 20, 1903. No. 59345 A.

MEASUREMENT.

Current Meters.

See Mechanical Engineering, Hydraulics.

Flow.

The Pitot Tube. W. B. Gregory. Calls attention to the use of this instrument in measuring the velocity of fluids. Ill. 6800 w. Trans Am Soc of Mech Engrs, No. 015 —Dec., 1903. No. 59327 C.

Slide Rules.

Slide Rules for the Machine Shop as a Part of the Taylor System of Management. Carl G. Barth. Explains the slide rule method of solution of various problems. 3800 w. Trans Am Soc of Mech Engrs, No. 013—Dec., 1903. No. 59325.

Testing Apparatus.

Air Motors and Air Hammers. Max H. Wickhorst. Illustrates and describes apparatus and methods used in extensive tests of air-drill motors and air hammers, to determine the air consumption, horsepower, stalling load of motors, number and force of hammer blows, &c. 1600 w. Trans Am Soc of Mech Engrs, No. 02—Dec., 1903. No. 59316.

Testing.

Experiments on the Resistance of Steel Castings (Versuche über die Festigkeitseigenschaften von Stahlguss). C. Bach. Data and results of an extensive and accurate series of tests of the strength of steel castings at ordinary and higher temperatures. Two articles. 10000 w. 3 plates. Zeitschr d Ver Deutscher Ing—Dec. 5, 12, 1903. No. 59815. Each D.

Valve Motion.

The Theory of the Stephenson Link Valve Motion. William N. Barnard. Develops a simple method of analyzing the Stephenson Link Mechanism, which is based largely on that given in Bilgram's Valve Gears. 2400 w. Sib Jour of Engng —Dec., 1903. No. 59791 C.

POWER AND TRANSMISSION.

Air Compressors.

An Improvement in Valve-Motion of Duplex Air Compressors. Sterling H. Bunnell. Illustrates and describes the construction. 1000 w. Trans Am Soc of Mech Engrs, No. 06—Dec., 1903. No. 59320.

Cranes.

One-Hundred-Ton Steel Floating Crane. Lieut. Jos. S. Shultz. Illustration, with description of the pontoon crane at the New York Navy Yard. 1200 w. Eng Rec —Dec. 19, 1903. No. 59671.

Twenty-Ton Breakdown Crane. Illustrated description. 600 w. Engr, Lond—Nov. 20, 1903. No. 59353 A.

See Electrical Engineering, Power Applications.

Factory Traction.

Modern Factory Traction. Clarence J. Messer. On the advantages of a telpherage plant, with information of interest. Ill. 2500 w. Cassier's Mag—Dec., 1903. No. 59748 B.

Power Cost.

Cost of Production of Power from Fuel.

T. L. Miller. Abstracts from the presidential address before the Liverpool Engng Soc. Gives details of cost per h. p. of steam power plants. 1500 w. Mech Engr —Dec. 12, 1903. No. 59718 A.

Rope Transmission.

Some Difficulties of Rope Transmission. Arthur Holmes Morse. Considers difficulties in designing rope-drives, discussing the defects. 5000 w. Harvard Engng Jour —Nov., 1903. No. 59308 C.

The Transmission of Power by Ropes. Edwin Kenyon. Abstract of a paper read before the Staffordshire Iron and Steel Inst. Discusses cost and the applications to practice, systems, &c. 4000 w. Ir & Coal Trds Rev—Nov. 27, 1903. No. 59512 A.

Transmission of Power by Ropes. Explains the English and American systems, discussing factors that favor this method, and points in designing of drives. 1400 w. Min & Sci Pr—Dec. 12, 1903. No. 59692.

St. Louis Exposition.

Power and Machinery at the St. Louis World's Fair. An interesting report of noteworthy engineering features. 3500 w. Ir Age—Dec. 10, 1903. No. 59505.

Steam Shovel.

A Steam Shovel of Novel Design. Illustrated description of a new type of excavating machinery which dispenses with the usual equipment of hoisting engine, drums, chains, clutches, &c. 1000 w. Eng News—Dec. 17, 1903. No. 59702.

Variable Speeds.

Variable Speeds for the Planing Machine. Frank B. Kleinhans. Illustrates and describes methods of obtaining variable speed. 1200 w. Am Mach—Dec. 17, 1903. No. 59666.

SPECIAL MOTORS.

Alcohol.

Alcohol as a Motive Power. From the French of M. O. Boudouard, in *Revue de Chimie Industrielle*. Gives a study of alcohol motors, comparing with gasoline, and the results obtained. 1500 w. Sci Am Sup—Dec. 5, 1903. No. 59481.

Alcohol as a Source of Motive Power (L'Alcohol et la Force Motrice). An examination of the availability of alcohol for use in internal-combustion motors, showing its high efficiency. 2000 w. Revue Technique—Dec. 10, 1903. No. 59832 D.

Gas Engine.

A Compact Gas Engine: Beam Type. C. H. Morgan. Illustrates and describes an engine designed with special reference to the use of blast furnace and producer gases. 2000 w. Trans Am Soc of Mech Engrs, No. 016—Dec., 1903. No. 59328.

A Gas Engine Pumping Station. Illustrates and describes the application of gas engines to pumping in the plant of the Pittsburg Plate Glass Co. 2200 w. Power —Dec., 1903. No. 59502 C.

Blast Furnace Gas Engines at the Lackawanna Steel Company's Plant. An illustrated detailed description of the plant at Buffalo, N. Y., which is the largest gas engine plant yet installed. 2400 w. Power —Dec., 1903. No. 59495 C.

Recent Developments in the Construction and Working of Gas Engines. Prof. D. S. Capper. Honorary member's paper read before the Junior Inst. of Engrs. Reviews the important points in the early history, and shows how recent improvements in construction have in some respects placed it in advance of the steam engine. General discussion. 10000 w. Jour Gas Lgt—Dec. 8, 1903. No. 59716 A.

The Blast-Furnace Gas Engine Plant of the Kladno Iron Works (Hochofengas maschinen-Anlage im Eisenwerke Kladno). Karl Machacek. Describing the installation and operation of two 500 h. p. engines, with indicator diagrams and data of tests. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 20, 1903. No. 59820 D.

The Irregularity of Gas Engine Speeds (Der Ungleichformigkeitsgrad von Gasmotoren mit Aussetzerregelung). Dr. R. Mollier. An examination into the degree of irregularity in speed of gas engines provided with hit-and-miss governors. 1200 w. Zeitschr d Ver Deutscher Ing—Nov. 21, 1903. No. 59812 D.

The Starting of Large Gas Engines. E. W. Roberts. Reviews methods, and devices used in the starting of large gasoline marine engines. Ill. 1700 w. Marine Engng—Dec., 1903. No. 59507 C.

See Also Electrical Engineering, Generating Stations.

Gas Power.

See Gas Works Engineering.

Ignition.

Advance of Ignition and Duration of Explosion (L'Avance à l'Allumage et la Durée des Explosions). J. Petin. An examination of the causes and effects of ignition of the charge in a gas engine before the piston reaches the end of the stroke; showing the relation of advance to speed. 1800 w. Génie Civil—Nov. 14, 1903. No. 59801 D.

Sulphurous Anhydride.

The Pressure Temperature Curve of Sulphurous Anhydride. Edward F. Miller. Gives results of experimental determinations. 1000 w. Trans Am Soc

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of Mech Engrs. No. 010—Dec., 1903. No. 59322.

STEAM ENGINEERING.

Balancing.

Balancing Marine Engines. A mathematical discussion of the vibratory effects. Ill. 1900 w. Naut Gaz—Dec. 3, 1903. No. 59446.

Blowing Engines.

The Westinghouse Blowing Engine. Illustrated detailed description of the construction. 2700 w. Ir Age—Dec. 3, 1903. No. 59378.

The Westinghouse Blowing-Engine. Illustrated detailed description of a new design of the long cross-head type. 2500 w. Engng—Dec. 11, 1903. No. 59734 A.

Boiler Making.

The Manufacture of the Niclausse Boiler (Die Herstellung der Niclausse Kessel). Friedrich Geiseler. A very fully illustrated account of the special machinery and methods used in making the Niclausse water-tube boiler, both at the works of Willans and Robinson, and of J. & A. Niclausse. 2500 w. Zeitschr d Ver Deutscher Ing—Dec. 12, 1903. No. 59818 D.

Boiler Material.

The Study of Material for Boiler Construction (Beitrag zur Materialkenntnis für den Kesselbau). H. Otto. A comparison of tests taken from various portions of a boiler plate. 2000 w. Stahl u Eisen—Dec. 15, 1903. No. 59841 D.

Boilers.

A Water-Tube Locomotive Boiler. Illustrates and describes the design of J. M. McClellon. 900 w. Loc Engng—Dec., 1903. No. 59394 C.

Boiler Design. H. K. Spencer. The first of a series of articles discussing things to be considered in determining the type of machinery to power a vessel, especially the design of boiler. Ill. 2500 w. Marine Engng—Dec., 1903. Serial. 1st part. No. 59509 C.

Characteristics of the Normand Water-Tube Boiler. Augustin Normand, Jr. Illustrated detailed description. 3000 w. Jour Am Soc of Nav Engrs—Nov., 1903. No. 59565 H.

Notes on the Design of Vertical Boilers. Considers important points in design, the neglect of which often causes defects and sources of trouble. Ill. 3000 w. Mech Engr—Dec 5, 1903. Serial. 1st part. No. 59617 A.

Report of U. S. Naval Officers on Boilers of U. S. S. Maine. 5400 w. Jour Am Soc of Nav Engrs—Nov., 1903. No. 59561 H.

The Niclausse Boiler. Charles M. Howe. A brief illustrated description of this boiler as designed and built in the United States, with data from official error. 9000 w. Jour Am Soc of Nav Engrs—Nov., 1903. No. 59569 H.

The Water-Tube Boiler in the British Fleet. Archibald S. Hurd. An account of the conditions under which this type of boiler was introduced, with remarks on the virtues of this type, and the future outlook. 3300 w. Sci Am Sup—Nov. 28, 1903. No. 59337.

Water-Tube *vs.* Cylindrical Boilers for Naval Vessels. W. Ledyard Cathcart. Reviews the history of the water-tube boiler in marine service, its efficiency, difficulties met, military value, &c., concluding that its advantages make the use of the cylindrical type a grave military error. 9000 w. Jour Am Soc of Nav Engrs—Nov., 1903. No. 59560 H.

Combustion.

Experiments in Steaming with Low Grade Coals (Verdampfungs-Versuch mit Magerkohle). Results of tests made by the Dortmund Boiler Inspection Association, using ordinary draft and steam blast. 1500 w. Glückauf—Dec. 5, 1903. No. 59848 D.

Condensing.

Condensing Plant for High Vacuum with Limited Water Supply. W. H. Roy. Read before the Manchester Assn. of Engrs. Discusses the best type of cooler and the theory and limits of condensing plant efficiency, especially in relation to high vacuum. 3500 w. Mech Engr—Dec. 12, 1903. Serial. 1st part. No. 59719 A.

Saturated Air Condensers. Statistics of tests comparing the relative efficiency and current expense of a saturated air surface condenser and a standard brass tube condenser. 2000 w. Power—Dec., 1903. No. 59496 C.

Economizers.

An Economizer Discussion. Edwin B. Katte. A basis for discussion of the advisability of installing fuel economizers. Followed by papers by A. H. Blackburn, William Downs, R. D. Tomlinson, J. E. Moulthrop, and general discussion. 11200 w. Pro N Y R R Club—Oct. 16, 1903. No. 59306.

Engine Driving.

Notes on Engine Driving in Electric Light Stations. F. T. Callis. Remarks on the changes in design and building of stationary engines, types, methods of lubrication, starting and stopping, &c. 2000 w. Elec Rev, Lond—Dec. 11, 1903. Serial. 1st part. No. 59727 A.

Engine Tests.

Tests of a Compound Engine Using Superheated Steam. Prof. D. S. Jacobus.

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Report of tests made to determine whether the builder's guarantee was fulfilled. 2500 w. Trans Am Soc of Mech Engrs, No. 08—Dec., 1903. No. 59382.

Evaporation.

A Series Distilling Apparatus of High Efficiency. W. F. M. Goss. Illustrates and describes apparatus designed to purify water or other liquids by distillation. 3000 w. Trans Am Soc of Mech Engrs, No. 03—Dec., 1903. No. 59317.

Multiple Effect Evaporators. Reviews an article by M. Sekutowicz, in the Sept. *Bulletin* of La Société des Ingenieurs Civils de France. On the evaporation apparatus employed in French sugar factories, and related subjects. 1800 w. Engr, Lond —Nov. 20, 1903. No. 59350 A.

Researches on the Transmission of Heat (Recherches sur la Transmission de la Chaleur). M. Sekutowicz. A very complete investigation of the action of heat in multiple-effect evaporating apparatus. 15000 w. Mem Soc Ing Civ de France—Sept., 1903. No. 59874 G.

Expansion.

Diagram for Adiabatic Expansion of Steam. Sven S. Ekman. Describes a graphical method of calculating the velocity of steam, expanding adiabatically, &c. 2000 w. Power—Dec., 1903. No. 59500 C.

Feeding Boilers.

Piping for Feed Water and Blow-Offs. C. B. Risley. Discusses methods of feeding, and arrangements for blowing off. 1500 w. Engr, U S A—Dec. 1, 1903. No. 59370 C.

Flywheels

Reducing the Windage of Flywheels. F. W. Salmon. Illustrated article on the advantages of making shields for flywheels, resulting in a saving in fuel and less liability of accident. 1000 w. Power —Dec., 1903. No. 59501 C.

The Use of Flywheels upon Machine Tools. J. C. Steen. Discusses briefly the application to various classes of machinery. 1500 w. Am Engr & R R Jour—Dec., 1903. No. 59399 C.

Foundation Bolts.

Foundation Bolts for Steam Engines. W. H. Wakeman. Suggestions helpful in the proper setting of engines, illustrating some defects. 1000 w. Elec, N Y—Dec. 16, 1903. Serial. 1st part. No. 59589.

Governor.

The Centrifugal Throttle Governor. Ernest R. Briggs. Illustrates and describes a form of governor much used in England. 1600 w. Am Mach—Dec. 17, 1903. No. 59662.

Indicators.

The Development of the Outside Spring Indicator. Robert Grimshaw. Illustrations showing the development, with explanatory notes. 400 w. Power—Dec., 1903. No. 59498 C.

The Testing of Indicator Springs (Prüfung von Indikator federn). H. Staus. An account of the testing work done in the laboratory of the technical high school at Karlsruhe. 1200 w. Zeitschr d Ver Deutscher Ing—Dec. 12, 1903. No. 59819 D.

Leaky Flues.

Leaky Fire Boxes and Tubes. Editorial discussing the causes of this trouble. 1200 w. Loc Engng—Dec., 1903. No. 59396 C.

Mechanical Stokers.

Stokers for Electricity Generating Stations. Albert Gay. Read before the Soc. of Engrs. Considers the essentials of perfect combustion, and various types of mechanical stokers which aim to increase the economy in the raising of steam. Ill. 5000 w. Elect'n, Lond—Dec. 11, 1903. No. 59722 A.

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Physics.

The Misuse of Physics by Biologists and Engineers. W. S. Franklin. Abstract of a paper read before the Am. Physical Soc. Calls attention to some of the precise notions of thermodynamics, pointing out the essential limitations of that subject. 4000 w. Elec Rev, N Y—Dec. 5, 1903. No. 59465.

Power Plant.

Power Plant with Mechanical Draught. Illustrated description of an interesting plant in Berlin, designed by Prof. E. Josse, where it was necessary to use as little space as possible. 2300 w. Engng—Dec. 18, 1903. Serial. 1st part. No. 59773 A.

Reversing Engine.

Investigations of a Tandem Double Reversing Engine (Versuchsergebnisse an einer Tandem Zwillingsreversiermaschine). Data and results of tests of a double cylinder rolling-mill engine with the Rottmann valve gear. 1000 w. Stahl u Eisen —Dec. 1, 1903. No. 59839 D.

Slide Valves.

The "Missing Quantity" in Double Slide-valve Gears (Das Fehlerglied bei Doppelschiebersteuerungen). H. Gauhe. An examination of the error in valve motion due to the angularity of the connecting

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rod. 1000 w. Zeitschr d Ver Deutscher Ing—Dec. 5, 1903. No. 59817 D.

Speed Regulation.

Regulation of Engines for Driving Dynamos (Régulation des Moteurs Appliqués à la Commande des Machines Dynamo-Electriques). R. V. Picou. A discussion of the causes of speed variation in electrical generating sets and the modifications in the governing apparatus devised to improve the regulation. 8000 w. Mem Soc Ing Civ de France—Oct., 1903. No. 59876 G.

Stacks.

Some Experiments with Stacks and Exhaust Pipes. T. H. Symington. From a paper before the Richmond Ry. Club. An account of experimental investigations made and the results. 2500 w. Ry & Engng Rev—Nov. 28, 1903. No. 59450.

Steam.

The Science of Steam Generation. F. J Rowan. An illustrated article considering the many sides of the problem of designing a steam generator, and indicating possible improvements. 8000 w. Cassier's Mag—Dec., 1903. No. 59746 B.

Steam Engines.

Construction and Efficiency of a Fleming Four-Valve Engine Directly Connected to 400 K.W. Generator. Benjamin T. Allen. Describes the general construction of, and the results obtained from a new type of four-valve stationary engine. 2000 w. Trans Am Soc of Mech Engrs, No. 011—Dec., 1903. No. 59323.

The Engines for the London County Council Tramway Power-Station of Greenwich. An illustrated description of these engines, with information concerning the cost and requirements. 3000 w. Tram & Ry Wld—Dec. 10, 1903. No. 59729 B.

Steam Flow.

The Flow of Steam and Gases through Tubes of Varying Cross Section (Strömüng von Gasen und Dämpfen durch Rohre mit Veränderlichem Querschnitt). A Stodola. Comments on the investigations of Prof. Lorenz. 1200 w. Zeitschr d ver Deutscher Ing—Dec. 5, 1903. No. 59816 D.

Steam Turbines.

A New Steam Turbine Power Plant. Illustrates and describes the application of the electrical system of power distribution in the shops of the Mexican Cent. Ry. at Aguas Calientes, Mexico. 1300 w. Am Engr & R R Jour—Dec., 1903. No. 59400 C.

New Forms of the Steam Turbine. Robert H. Smith. An examination in detail of the statements of Prof. Dr. Riedler in regard to steam turbines, their design, construction, &c. 3500 w. Engr, Lond—Dec. 18, 1903. Serial. 1st part. No. 59777 A.

Notes on the Steam Turbine. Prof. Homer M. Jaquays. Read before the Canadian Soc. of Civ. Engrs. A review of modern turbines and the general principles of the chief types. Ill. 4800 w. Can Engr—Dec., 1903. No. 59445.

Some Notes on the Steam Turbine. Homer M. Jaquays. Illustrations and information concerning various types, the existing conditions and future outlook. 4500 w. Can Soc of Civ Engrs, Adv Proof—Dec., 1903. No. 59659 D.

Steam Turbines in Europe. Emile Guarini. An illustrated report of several installations and their performances. 1500 w. Power—Dec. 1, 1903. No. 59497 C.

Tests of Steam Turbines. Abstracts of the Naval Board reports of the Curtis and Parsons types. 3500 w. Ir Age—Dec. 3, 1903. No. 59379.

The Curtis Steam Turbine. Detailed drawing and description of general features. 2000 w. Elect'n, Lond—Nov. 20, 1903. No. 59354 A.

The Steam Turbine and the Future of Thermal Motor (Les Turbines à Vapeur et l'Avenir des Moteurs Thermiques). A. Stodola. A translation of Stodola's exhaustive discussion of the thermodynamics of the steam turbine from the *Zeitschrift des Vereines Deutscher Ingenieure*. Serial. Part 1. 12000 w. Revue de Mécanique—Nov. 30, 1903. No. 59838 E + F.

See also Marine and Naval Engineering.

Superheating.

Superheated Steam. F. J. Rowan. Read before the Inst. of Engrs. & Shipbuilders in Scotland. The present paper gives a historical review of investigators and their systems. Ill. 2200 w. Mech Engr —Nov. 28, 1903. Serial. 1st part. No. 59431 A.

The Computation of the Advantages of Superheating (Calcul du Bénéfice Du à la Surchauffe). M. Delaporte. A study of the advantages of superheating considered in connection with the steam engine as an imperfect machine. 5000 w. Revue de Mécanique—Nov. 30, 1903. No. 59837 E + F.

MISCELLANY.

Aeronautics.

Aeronautics in America (L'Aviation en Amerique). O. Chanute. A review of recent progress, with especial reference to the aeroplane experiments of the Wright brothers. 5000 w. Rev Gen des Sciences —Nov. 30, 1903. No. 59834 D.

By Motor Through the Air. Illustrated notes of recent developments in the adaptation of automobile motors to air navigation. 1200 w. Automobile—Nov. 28, 1903. No. 59339.

Rosy Views on Airship Matters. An il-

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lustrated article telling the story of Lebaudy balloon's last trip. 1000 w. Automobile—Dec. 19, 1903. No. 59687.

The Autumn Campaign of the Lebaudy (La Campagne d'Automne du Lebaudy). Col. G. Espitallier. A brief account of the experimental work which has been done with the Lebaudy dirigible balloon. 1000 w. Géne Civil—Dec. 5, 1903. No. 59808 D.

The Lebaudy Airship. Illustrated description. 1500 w. Sci Am—Dec. 5, 1903. No. 59480.

The Lebaudy Airship. Photographs, with description of interesting features. 1300 w. Auto Jour—Nov. 21, 1903. No. 59343 A.

Aluminothermics.

Aluminothermics and Some of Its Applications. An illustrated description of the thermit welding process and some of its applications as given in a lecture by Dr. Goldschmidt before the Columbia Univ. Chem. Soc. 1700 w. Am Elect'n —Dec., 1903. No. 59416.

Aluminothermy (L'Aluminothermie). C. Matignon. A description of the theory and practical applications of the Goldschmidt process of obtaining high temperatures by the combustion of metallic aluminum. 8000 w. Rev Gen des Sciences—Nov. 15, 1903. No. 59833 D.

Mechanical and Metallurgical Applications of Aluminothermics. E. Guarini. An illustrated account of the Goldschmidt process, with numerous examples of its practical applications to rail welding, and repairing of broken parts. 2000 w. Engineering Magazine—Jan., 1904. No. 59888 B.

Heating Costs.

Heating Costs of Various Systems. J. Byers Holbrook. Gives brief descriptions of the different systems, and a table of approximate costs. 3700 w. Eng Rec—Dec. 26, 1903. No. 59908.

Index.

An Engineering Index and File. Edward J. Kunze. An explanation of a system devised by the writer and found to be flexible and quite satisfactory. 3500 w. Am Mach—Dec. 17, 1903. No. 59676.

Kites.

The Tetrahedral Kites of Dr. Alexander Graham Bell. Gilbert H. Grosvenor. An illustrated article describing these kites and explaining the more important principles evolved. 4500 w. Pop Sci M—Dec., 1903. No. 59309 C.

Laboratory.

The Mechanical Laboratory of the Polytechnic School at Zurich (Das Machinenlaboratorium am Eidgenossischen Polytechnikum in Zürich). A very fully illustrated description of the new building and the equipment of the mechanical, hydraulic and electrical laboratories. Six articles. 8000 w. 3 plates. Schweizerische Bauzeitung—Oct. 17, 24, 31, Nov. 14, 21, Dec. 12, 1903. No. 59823. Each B.

The Mechanical Laboratory of the Royal Technical High School of Berlin. Walter Mentz. An illustrated review of the arrangement and working of this laboratory. 5800 w. Jour Am Soc of Nav Engrs—Nov., 1903. No. 59563 H.

Mechanical Plant.

The Mechanical Plant of the Broadway-Maiden Lane Building, New York. Illustrated description of a plant to supply the demands of an 18-story office building. 3000 w. Eng Rec—Dec. 19, 1903. No. 59673.

Operating Costs.

Cost of Operating Buildings. Gives results of some investigations recently made of a number of New York buildings, compiled from actual running expenses. 1000 w. Eng Rec—Dec. 19, 1903. No. 59669.

Refrigeration.

New Ice Manufacturing Plant in St. Louis. An illustrated description of a closed type plant located on one floor, the machinery, general equipment, &c. 3000 w. Ice & Refrig—Dec., 1903. No. 59391 C.

Refrigeration on Absorption System. Robert A. Whelan. Illustrates and describes details of operation. 4200 w. Ice & Refrig—Dec., 1903. No. 59392 C.

Standard Unit of Refrigeration. J. C. Bertsch. Urging the necessity of establishing a standard unit of refrigeration, and showing that for computing the capacities of refrigerating machines the temperatures are the only correct basis. 3300 w. Trans Am Soc of Mech Engrs, No. 05—Dec., 1903. No. 59319.

Society Houses.

The Homes of the Great Engineering Societies. H. H. Suplee. A fully illustrated description of the houses of the great national engineering societies. 4000 w. Engineering Magazine—Jan., 1903. No. 59886 B.

Thurston.

Biographical Notice of Robert H. Thurston. William Kent. A memorial number devoted to the life and work of Dr. Thurston. Photograph. 25000 w. Sib Jour of Engng—Nov., 1903. No. 59557 C.

Woodworking.

The Removal and Utilization of Shavings and Sawdust (Evacuation et Utilisation des Copeaux). Paul Razous. Describing various forms of conveyors and exhausters for attachment to woodworking machinery. Two articles. 3500 w. Génie Civil—Dec. 5, 12, 1903. No. 59805. Each D.

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MINING AND METALLURGY

COAL AND COKE.

Anthracite.

The Separation of Anthracite Coal from Slate. Guy H. Elmore. Address before the Engrs. Club of Scranton. Suggests applying ore concentration practice to coal washing or separating. 1000 w. Eng & Min Jour—Dec. 17, 1903. No. 59682.

Briquetting.

The Briquetting of Small Coal (Die Herstellung Kleinstückiger Briketts). Dr. Steger. A review of various briquetting processes with especial reference to the utilization of coal slack and fine coal Two articles. 5000 w. Stahl u Eisen—Dec. 1, 1903. No. 59840. Each D.

Canada.

The Coal and Iron Resources and Outlook of Canada. The present article is an introductory review. 2000 w. Ir & Coal Trds Rev—Dec. 4, 1903. Serial. 1st part. No. 59732 A.

Coal-Field.

Notes on the Westphalian Coal Field. David A. Louis. The present article describes the various methods of working the coal and the most recent systems of transport. 1300 w. Ill. Page's Mag—Dec., 1903. Serial. 1st part. No. 59750 B.

Coal Industry.

The Magnitude of the Coal Industry. F. E. Saward. Extracts from an address before the Modern Sciences Club of Brooklyn. Considers especially mining and distribution in the United States. 2500 w. Ir Age—Dec. 10, 1903. No. 59503.

Coke Handling.

Recent Coke Handling Machinery (Ueber Neuere Koksofen Beschickungsanlagen). O. Simmersbach. Describing recent installations of conveyors, and handling machinery in France and Germany. 2000 w. 1 plate. Stahl u Eisen—Dec. 15, 1903. No. 59842 D.

Electric Power.

See Electrical Engineering, Power Applications.

Foundry Coke.

See Mechanical Engineering, Machine Works and Foundries.

Kent.

Kent Coal. Report made by Mr. R. Etheridge, the consulting geologist to the consolidated Kent Collieries Corporation, Ltd., on the coal and coal-measure rocks being brought to the surface by the Kind-Chaudron, or new process, adopted for deep shaft and pit sinking. 2400 w. Col Guard—Nov. 27, 1903. No. 59438 A.

Montana.

Some Montana Coal Fields. J. Perry Rowe. A general idea is given of the extent of the bituminous and semi-bituminous coal fields of Montana. 4000 w. Am Geol—Dec., 1903. No. 59311 D.

New Colliery.

New Colliery at Bargoed. Illustrated description of a new colliery in the Rhymney Valley, on the boundary between England and Wales. 1200 w. Col Guard—Dec. 18, 1903. No. 59772 A.

New Zealand.

Westport Coal Company's Mine Creek Colliery. Urquhart Brand Inglis. Illustrations and brief description of colliery, with an outline of the method of getting out the coal. 1100 w. N Z Mines Rec—Oct. 16, 1903. No. 59441 B.

Peat.

See Electrical Engineering, Power Applications.

Preparation.

The Preparation of Coal (Kohlenaufbereitung). Alfred Müller. A discussion of the methods employed in Germany to aid hand picking in the separation of slate, dirt and other impurities from coal. 1800 w. Zeitschr d Ver Deutscher Ing—Nov. 28, 1903. No. 59814 D.

Re-Survey.

The Derbyshire and Nottinghamshire Coal Fields. A report of the re-survey of this field. 3500 w. Col Guard—Nov. 27, 1903. No. 59439 A.

Washing.

Coal Washing by the Stewart System. David T. Blakey. An illustrated description of the apparatus as installed for treating bituminous coal in Alabama. 1500 w. Mines & Min—Dec., 1903. No. 59387 C.

Washing Montana Coal. J. V. Schaefer. An illustrated description of the washing of the Montana Coal & Coke Co., at Aldridge, Park Co., Montana. 1300 w. Mines & Min—Dec, 1903. No. 59388 C.

COPPER.

Electrolytic Refining.

See Electrical Engineering, Electrochemistry.

Impurities.

The Effect of Impurities on Commercial Copper. Ernest A. Lewis. Considers

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the effects of single impurities on copper, with notes on the composition of various kinds of copper. 2200 w. Engng—Dec. 4, 1903. No. 59635 A.

New South Wales.

Mining Fields of New South Wales. F. Danvers Power. Remarks based on observations recently made. Deals with the Great Cobar Copper Works and the Lloyd Copper Company. 2300 w. Aust Min Stand—Nov. 12, 1903. No. 59756 B.

Smelting.

The New Flues and Stack at Anaconda. An illustrated description of new reduction works of the Washoe Copper Company, built to overcome trouble caused by smoke. 2200 w. Eng & Min Jour—Dec. 24, 1903. No. 59912.

GOLD AND SILVER.

Alaska.

The Treadwell Group of Mines, Douglas Island, Alaska. Robert A. Kinzie. History, geology and illustrated detailed description of mines and methods of ore that does not yield an average of more than $2 per ton. 13800 w. Trans Am Inst of Min Engrs—Oct., 1903. No. 59-545 D.

Arctic America.

Present Condition of Gold Mining in Arctic America. R. A. F. Penrose, Jr. Describes some of the difficulties found in the northwestern part of North America, the mines, and the Klondike region. Ill. 2000 w. Eng & Min Jour—Nov. 28, 1903. Serial. 1st part. No. 59330.

Australia.

Future Gold Production of Western Australia. Divides the mines into four groups, discussing the future outlook. 4800 w. Aust Min Stand—Nov. 19, 26, 1903. 2 parts. No. 59759 each B.

California.

Rich Gold Mines of Sierra County. George F. Taylor. Begins an illustrated account of a district with a recent yield of $190,000,000 from its placer and quartz mines. 3500 w. Pacific C Min—Dec. 19, 1903. Serial. 1st part. No. 59927.

Colloidal Gold.

Behavior of Red Colloidal Gold Solutions toward the Electric Current and toward Electrolytes. J. C. Blake. Describes experimental investigation. 2500 w. Am Jour of Sci—Dec., 1903. No. 59556 D.

Crushing.

A System of Crushing Rock in Stages by Wet Process and Suggestions as to How This Object Can Best be Achieved. Continued discussion of paper by Edward D. Chester, taken as read. 800 w. Jour Chem, Met & Min Soc of S. Africa—Oct., 1903. No. 59647 E.

Cyaniding.

A System of Handling Sand Mechanically for Cyanide Vats. Charles Butters and Albert F. Crank. Abstract of a paper read before the Inst. of Min. & Met., London. Describes the Virginia City plant for treating sands. 4000 w. Eng & Min Jour—Dec. 5, 1903. No. 59469.

The Cyaniding of Some Silver Ores by Percolation. André P. Griffiths and Frank W. Oldfield. Read before the Inst. of Min. & Met. Describes results obtained in a successfully worked percolation plant in Mexico. 2200 w. Can Min Rev—Nov. 30, 1903. No. 59460 B.

Deep Mines.

Deep Workings at the North Star Mines, California. E. L. Oliver. Describes an interesting shaft sunk 1625 feet to tap the North Star Ledge. 1000 w. Eng & Min Jour—Dec. 17, 1903. No. 59680.

Discovery.

Late Discovery of Gold Near Pratten, Talgia Goldfield. Lionel C. Ball. Gives the history of a discovery in Queensland. 1800 w. Queens Gov Min Jour—Oct. 15, 1903. No. 59418 B.

Gold-Field.

The Clunes Gold-Field (V.) A digest of the report furnished the Victorian Mines Department by William Bradford. 1500 w. Aust Min Stand—Nov. 12, 1903. No. 59757 B.

Laboratory Work.

School Laboratory Work. A Free-Milling Gold-Run. Robert H. Richards and E. E. Bugbee. A report of tests made and the results. 2000 w. Trans Am Inst of Min Engrs—Feb., 1903. No. 59536.

Losses.

Causes of Gold Mill Losses. Discusses the ways in which losses may occur, offering suggestions for correcting the trouble. 1800 w. Min & Sci Pr—Dec. 5, 1903. No. 59606.

Lower California.

The Ybarra Mines of Lower California. Brief illustrated description of this gold mine. 1000 w. Min & Sci Pr—Nov. 28, 1903. No. 59403.

Mexico.

Mexican Metallurgical Methods. A. W. Warwick. The present article gives an illustrated description of the Patio process. 1400 w. Min Rept—Dec. 17, 1903. Serial. 1st part. No. 59688.

Oregon.

Metals and Minerals of Southern Oregon. D. H. Stowell. List of metals and minerals of value found in this district. Gold, silver, and a great variety are found. 700 w. Min Rept—Nov. 26, 1903. No. 59335.

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Quartz Veins and Mines of Southern Oregon. Dennis H. Stovall. Considers the causes of the slow development in this region, describing the gold and silver deposits. 900 w. Min & Sci Pr—Dec. 12, 1903. No. 59694.

Ore Treatment.

Treatment of Cassilis Ore. William Aplin. Prize paper. Describes the treatment of these very refractory gold ores. 2800 w. Aust Min Stand—Nov. 5, & 12, 1903. 2 parts. No. 59754. Each B.

Placers.

Geology of the Apache Cañon Placers. 2000 w. Eng & Min Jour—Dec. 24, 1903. No. 59913.

Gold Placers in Bokhara. E. D. Levat. Abstract from *Annales des Mines*. Describes the rich gold deposits of Central Asia. 2200 w. Eng & Min Jour—Dec. 24, 1903. No. 59914.

The Alsek Placer District, Yukon Territory. W. M. Brewer. Map, with information from prospectors' reports. 800 w. Min & Sci Pr—Dec. 5, 1903. No. 59607.

Production.

The Geological Features of the Gold Production of North America. Discussion of the paper of Waldemar Lindgren at the New Haven meeting. 2000 w. Trans Am Inst of Min Engrs—Oct., 1902. No. 59538.

Slimes.

Slimes Process at the Consolidated Mercur Gold Mines. George Moore: An illustrated description of the Moore process fillers in operation. 1200 w. Eng & Min Jour—Dec. 5, 1903. No. 59470.

Thunder Mountain.

Thunder Mountain District, Idaho. A. E. Borthwick. A brief article giving information of this region and reporting a few of the properties in the porphyry belt. 900 w. Min & Sci Pr—Dec. 12, 1903. No. 59693.

Thunder Mountain District. William E. L'Hame. Describes the geological peculiarities and the situation of the various regions of this gold, silver and copper district. 4500 w. Mines & Min—Dec., 1903. No. 59386 C.

Victoria.

The Pyrenees Goldfield (V.) W. Bradford. Describes the topography and deposits. 1500 w. Aust Min Stand—Oct., 22, 1903. No. 59363 B.

Witwatersrand.

The Investigation of Old Mine Workings on the Witwatersrand. T. Lane Carter. An account of some valuable finds and work in progress. 1300 w. Eng & Min Jour—Dec. 17, 1903. No. 59683.

IRON AND STEEL.

Bilbao.

The Iron Ore Industry at Bilbao. Editorial discussion of the situation at these noted Spanish mines, the recent strike, the working, quality, &c. 1500 w. Engng—Dec. 18, 1903. No. 59775 A.

Blast-Furnace Practice.

Hearth-Areas and the Number of Tuyeres in Iron Blast-Furnace Practice. F. L. Grammer. Discusses blast-furnace practice, the means of determining the number of tuyeres required, &c. 3400 w. Trans Am Inst of Min Engrs—Oct., 1903. No. 59537.

Cast Iron.

See Mechanical Engineering, Machine Works and Foundries.

Charging Machine.

See Electrical Engineering, Power Applications.

Electric Smelting.

See Electrical Engineering, Electrochemistry.

Gas Furnaces.

Gas Furnaces for Melting and Heating (Einiges über Gas-Schweissund Wärmöfen). T. Stapf. An examination of the conditions of combustion in gas furnaces, showing their adaptability to metallurgical operations. 6000 w. Stahl u Eisen—Dec. 15, 1903. No. 59843 D.

Guns and Armor.

Gun Steel and Armor Plate. An illustrated description of the plant of the Bethlehem Steel Company and its processes. 3000 w. Sci Am—Dec. 12, 1903. No. 59528.

Ingots.

A New Process for Avoiding Piping in Steel Ingots. From *Stahl und Eisen*. An illustrated account of a process which attempts to reduce the required volume by maintaining a high temperature in the head. 2300 w. Ir & Coal Trds Rev—Dec. 18, 1903. No. 59926 A.

Lapland.

Iron Ores of Arctic Lapland. Chas. S. Osborn. Brief account of iron ore fields beyond the Arctic Circle. 1200 w. Aust Min Stand—Nov. 19, 1903. No. 59758 B.

Rolls.

Notes on the Design of Rolls. Emil Kirchberg. From *Stahl und Eisen*. An illustrated article discussing changes and progress, material, &c. 3800 w. Ir Age—Dec. 10, 1903. No. 59504.

Steel.

See Mechanical Engineering, Machine Works and Foundries.

Steel Rails.

The Manufacture of Steel Rails. An

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illustrated description of the Edgar Thomson Works, as representative of the scale of these establishments in the United States, and the methods of labor-saving. 2300 w. Sci Am—Dec. 12, 1903. No. 59527.

Steel Trade.

See Industrial Economy.

Structural Steel.

Manufacture of Bridge and Building Structural Shapes. An illustrated description of the Pencoyd Iron Works as representative of the United States plants and methods. 1500 w. Sci Am—Dec. 12, 1903. No. 59529.

MINING.

Anemometers.

The Anemometer Testing Station of the Westphalian Mining Association at Bochum (Mitteilungen aus der Anemometer-Prüfungsstation der Westfälischen Berggewerkschaftkasse in Bochum). H. Stach. With illustrations of a variety of anemometers used in measuring air currents in mines and the methods used in calibrating them. 4000 w. Glückauf—Nov. 28, 1903. No. 59846 D.

Deep Mining.

The Limits and Possibilities of Deep Mining. E. H. Roberton. A discussion of the problems of temperature, pressure, and deep-winding machinery, and the extent to which they have been solved. 3500 w. Engineering Magazine—Jan., 1903. No. 59887 B.

Electric Power.

See Electrical Engineering, Power Applications.

Explosives.

The Manufacture of Nitro-Glycerine Explosives. William Cullen. Notes explaining the different processes involved. 2300 w. Jour Chem Met & Min Soc of S Africa—Oct., 1903. No. 59645 E.

Milling.

The Ferraris Ball-Mill. Walter Renton Ingalls. An illustrated detailed description of a new device, designed especially for wet crushing, with remarks. 1400 w. Eng & Min Jour—Nov. 28, 1903. No. 59331.

Mine Gases.

Some Mine Gases: Their Toxicology and Possible Connection with Miners' Phthisis. Continued discussion of a paper by A. Heymann. 10000 w. Jour Chem, Met & Min Soc of S Africa—Oct., 1903. No. 59646 E.

Mine Improvements.

The Mineville Magnetite Mines. Illustrates and describes recent improvements of the mining and separating plant of Witherbee, Sherman & Co., Port Henry, N. Y. 8000 w. Ir Age—Dec. 17, 1903. No. 59625.

Miners.

See Industrial Economy.

Ore Bodies.

On the Differentiation of Igneous Magmas and the Formation of Ores. Jas. F. Kemp. A discussion of interest to mining engineers. 2000 w. Eng & Min Jour—Nov. 28, 1903. No. 59329.

Ore-Deposits.

Ore Deposits Near Igneous Contacts. W. L. Austin. A discussion of the paper of Walter Harvey Weed, at the New Haven meeting. 2800 w. Trans Am Inst of Min Engrs—Oct., 1902. No. 59540.

The Chemistry of Ore-Deposition. John A. Church. Discussion of the paper of Walter P. Jenney at the New Haven meeting. 2000 w. Trans Am Inst of Min Engrs—Oct., 1902. No. 59539.

Ore Testing.

Testing Ores by Vanning. Richard Pearce. Illustrates and describes various experiments in concentration by vanning, showing the usefulness of the vanning shovel. 1800 w. Eng & Min Jour—Dec. 24, 1903. No. 59911.

Rope Haulage.

New Endless-Rope Haulage Plant. Erskine Ramsay. Describes the plant at Slope No. 3, Pratt Mines Div., Tennessee Coal, Iron & Railroad Co., in Alabama. 2000 w. Mines & Min—Dec., 1903. No. 59389 C.

Separator.

The Freid Gravity Dry-Process Separator. Douglass McLean. Illustrated description. 800 w. Eng & Min Jour—Dec. 24, 1903. No. 59915.

Shaft Sinking.

Refrigeration in Shaft Sinking. Gives details of a difficult shaft put down in Holland, the machinery and apparatus used. Ill. 3800 w. Ice & Refrig—Dec., 1903. No. 59393 C.

Shafts.

Iron Shaft Fittings with Single Guides (Eiserner Schachtausbau mit Einseitiger Korbführung). F. Schulte. Showing an arrangement of structural iron work to replace the ordinary timbering used in mine shafts. 1800 w. Glückauf—Dec. 12, 1903. No. 59851 D.

Smelting.

Notes and Freehand Sketches Around the Omaha and Grant Lead Smelter at Denver, Colo. Prof. Arthur Lakes. A pictorial description of the principal processes. 2000 w. Mines & Min—Dec., 1903. No. 59390 C.

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Steam Shovels.

Steam Shovels in Mines. George E. Cole. Illustrated description of these machines and their work in the Granby Co.'s ore quarries at Phœnix, B. C. 1500 w. B. C. Min Rec—Dec., 1903. No. 59604 B.

Vanning-Buddle.

The Sperry Vanning-Buddle. Edwin A. Sperry. An illustrated description of the machines, with statement of some of the results obtained. 3000 w. Trans Am. Inst of Min Engrs—Oct., 1903. No. 59542.

Winding.

A Winding Engine Problem. Working out an example to show how simple methods may be used to solve fairly difficult problems of a practical kind when they are properly applied. 2700 w. Engr, Lond—Dec. 11, 1903. No. 59736 A.

Blosfeld's Safety Brake for Winding Engines. Illustrated detailed description of the "Hercules" safety brake. 1500 w. Ir & Coal Trds Rev—Dec. 18, 1903. No. 59925 A.

Safety Appliances for the Prevention of Overwinding. Illustrated description of various types. 2800 w. Col Guard—Dec. 4, 1903. Serial. 1st part. No. 59634 A.

MISCELLANY.

Asphalt.

Asphalt Mining and Refining in the Indian Territory. W. R. Crane. Describes the deposits, methods of prospecting, mining, milling and refining. 3500 w. Eng & Min Jour—Dec. 19, 1903. No. 59681.

Assaying.

The Assay of Zinc-Box Residues from the Cyanide Process. Richard W. Lodge. Describes experiments made at the Massachusetts Institute of Technology. 5000 w. Trans Am Inst of Min Engrs—Oct., 1903. No. 59544.

The Reduction of Lead from Litharge in Preliminary Assays, and the Advantages of an Oxide Slag. E. H. Miller, E. J. Hall and M. J. Falk. A study of this subject, giving conclusions of the tests described. 3000 w. Trans Am Inst of Min Engrs—Oct., 1903. No. 59543.

Cobalt.

Cobalt Mining in New Caledonia. Geo. M. Colvocoresses. Gives the history, formation and working of the ore, and general information. Ill. 2200 w. Eng & Min Jour—Nov. 28, 1903. No. 59333.

Dodge.

Biographical Notice of William Earl Dodge. James Douglas. Especially reviews the influence and interest in mining and metallurgical work. Photograph. 2000 w. Trans Am Inst of Min Engrs—Oct., 1903. No. 59533.

Lead.

Sources of Lead Production in the United States. Walter Renton Ingalls. Gives statistics of value, with brief reports of important districts. 2000 w. Eng & Min Jour—Nov. 28, 1903. No. 59332.

Lesley.

Biographical Notice of J. Peter Lesley. Benjamin Smith Lyman. An account of his life and work. Photograph. 2400 w. Trans Am Inst of Min Engrs—Oct., 1903. No. 59534 C.

Petroleum.

Petroleum (Le Pétrole). M. Lespeo. The first portion of a general study of the production and refining of petroleum in various portions of the earth. Serial. Part 1. 3000 w. Revue Technique—Nov. 25, 1903. No. 59830 D.

Quicksilver.

The Quicksilver Mines of Idria. T. L. Genter. Illustrated description of these mines in Australia, the second largest known. 2000 w. Eng & Min Jour—Dec. 17, 1903. No. 59679.

Tin.

Crow's Nest Tin Deposits. Lionel C. Ball. Report on the geology and workings of deposits in Queensland. 3000 w. Queens Gov Min Jour—Oct. 15, 1903. No. 59419 B.

Zinc.

The Wisconsin Zinc-Fields. Frank Nicholson. An account of the geology of the district, the development, deposits, &c. Ill. 3000 w. Eng & Min Jour—Dec. 5, 1903. No. 59468.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Train Heating.

Train Heating by Steam and Compressed Air (L'Application Générale du Chauffage des Trains par la Vapeur et L'Air Comprimé Combiné). M. Lancrenon. An account of the results obtained on the Eastern Railway of France. 6000 w. 2 plates. Rev Gen des Chem de Fer—Nov., 1903. No. 59879 G.

Train Resistance.

Experiments upon Train Resistance

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(Versuche über den Widerstand von Eisenbahnzügen). Rolf Sanzin. A comparison of the results of French, German and Austrian experiments, giving curves representing the mean results. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 4, 1903. No. 59821 D.

Train Resistance. C. O. Mailloux. Summarizes the important fundamental laws and discusses their application to train propulsion. 4500 w. Harvard Engng Jour—Nov., 1903. Serial. 1st part. No. 59307 C.

MOTIVE POWER AND EQUIPMENT.

Brake.

The Lipkowski Compressed Air Brake (Frein Automatique à Air Comprimé). F. Barbier. Illustrating and describing a modification of the Westinghouse brake, used in France and Russia. 2000 w. 1 plate. Génie Civil—Dec. 5, 1903. No. 59806.

Breakage.

Breakage of Car Equipment, Past, Present and Future, Cause and Remedy. Charles Waughop. Short paper presenting facts bearing on this subject, followed by discussion. 8000 w. St. Louis Ry Club—Nov. 13, 1903. No. 59555.

Cars.

Chicago Great Western House and Buffet Cars. Illustrates and describes special cars having original features of interest. 800 w. Ry Age—Dec. 18, 1903. No. 59689.

Counterbalancing.

Locomotive Counterbalancing. Review of the paper of R. A. Parke, before the New England R. R. Club, giving formulæ deduced for correctly counterbalancing the locomotives. 2200 w. R R Gaz—Dec. 11, 1903. No. 59520.

Leakage.

Leaky Tubes and Fireboxes. A. Parfitt. A boilermaker's opinion of some causes of trouble, and ways of remedying. 4500 w. Ry & Engng Rev—Dec. 12, 1903. No. 59588.

Train Pipe Leakage. C. C. Farmer. Discusses the causes and methods of preventing, the troubles caused by it, &c. General discussion. 6000 w. W Ry Club—Nov. 17, 1903. No. 59550 C.

Locomotives.

Heavy Freight Locomotive. Illustrates and describes some of the details of construction. 600 w. Am Engr & R R Jour—Dec., 1903. No. 59398 C.

Multi-Cylinder Locomotives. J. F. Gairns. An illustrated review of the world's practice in multi-cylinder simple and compound locomotives. 4000 w. Cassier's Mag—Dec., 1903. Serial. 1st part. No. 59745 B.

Narrow Gauge Locomotives for Heavy Grades and Sharp Curves (Les Locomotives pour Voie Etroite avec Fortes Rampes et Courbes de Faible Rayon). R. Bonnin. Illustrating locomotives of the Fairlie and Mallet types. 2000 w. Revue Technique—Dec. 10, 1903. No. 59831 D.

Six-Wheels Coupled Express Locomotive.—Chemin de Fer de l'Est. Illustrated description. 500 w. Engr, Lond—Dec. 11, 1903. No. 59742 A.

The Constructional Details of Modern Locomotives. Charles S. Lake. The first of a series of illustrated articles dealing with present-day practice. 2000 w. Prac Engr—Dec. 4, 1903. Serial. 1st part. No. 59615 A.

The French Locomotive for the Great Western Railway. Charles Rous-Marten. On the latest engine of the de Glehn compound type—No. 102. Ill. 2500 w. Engr, Lond—Dec. 4, 1903. No. 59641 A.

The New Caledonian Engines. An account of their performance, with cuts illustrating the boiler used. 800 w. Loc Engng—Dec., 1903. No. 59395 C.

The "Santa Fe" Type Tandem Compound. An illustrated description of the 2-10-2 type which has five pairs of drivers, with a pony truck in front and rear. 500 w. Ry Age—Nov. 27, 1903. No. 59366.

The Trend of Locomotive Proportions. Curves and tables, illustrating the trend which proportions have followed, with explanatory notes. 900 w. Ry Mas Mech—Dec., 1903. No. 59401.

Trevithick's Locomotive Experiment in 1808. In regard to a trial of a locomotive in the year 1808, giving extracts from the newspapers of the day. 1300 w. Engr, Lond—Dec. 18, 1903. No. 59778 A.

Staybolts.

Staybolts. H. A. Ferguson. Discusses some of the most frequent causes of staybolt failures, and the means of minimizing the trouble. General discussion follows. 7000 w. W Ry Club—Nov. 17, 1903. No. 59549 C.

Wrecking Outfits.

The New York Central Wrecking Outfits. Illustrated detailed description. 1700 w. R R Gaz—Dec. 4, 1903. No. 59491.

NEW PROJECTS.

Alaska.

Two New Railroads in Alaska. Illustrated description of the Council City and Solomon River line, and the Alaska Central. Map. 1600 w. R R Gaz—Dec. 18, 1903. No. 59705.

Improvements.

The Newark Improvements of the Lackawanna Railroad. An illustrated account of work for eliminating grade crossings and improving alignment and grades. 2500

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w. Eng Rec—Dec. 26, 1903. Serial. 1st part. No. 59907.

N. Y. Central R. R.

Electric Traction for the New York Central Railroad. Information concerning the contracts just awarded for the equipment of the lines near New York City with electricity. Also editorial. 2000 w. Elec Wld & Engr—Nov. 28, 1903. No. 59373.

Ogden-Lucin.

Driving Last Spike on the Ogden-Lucin Cut-Off. An illustrated account of the completion of this great engineering work, with facts concerning it. Map. 2000 w. Ry Age—Dec. 11, 1903. No. 59590.

Transandine.

The Transandine Railway. Charles M. Pepper. Discusses the probability of connecting Valparaiso and Buenos Ayres by rail, the conditions, what has been done, and matters related. 2000 w. Ry Age—Dec. 11, 1903. No. 59591.

PERMANENT WAY AND BUILDINGS.

Ballast.

Stone Ballast. E. A. Hermann. Remarks on the tendency to replace ballast formerly used with crushed stone, giving the claims of superiority. 700 w. Eng News—Dec. 17, 1903. No. 59700.

Dynamometer Car.

The Recording Apparatus on the Northern Railway of France (L'Appareil Enregistreur Employé sur le Reseau du Nord.) M. Rossignol. A description of the recording dynamometer car used for investigating the condition of the permanent way on the Northern Railway of France. 4000 w. Rev Gen des Chem de Fer—Dec., 1903. No. 59880 G.

Improvements.

Delaware, Lackawanna & Western Railroad Improvements at Newark and Harrison, N. J. Illustrated detailed description of extensive work of eliminating grade crossings and reducing grades, costing approximately $3,500,000. 2500 w. Ry Age—Dec. 4, 1903. No. 59461.

Wabash Steel-Concrete Construction. An illustrated description of work under way or completed on this line, noting details of interest 1200 w. Ry Age—Dec. 11, 1903. No. 59592.

Lapland.

The Northernmost Railway in the World (Die Nördlichste Eisenbahn der Erde). H. Claus. A description, with maps, of the railway from the iron-ore deposits of Gellivara to Narvik on the Ofoten-Fiord. 2000 w. Glasers Annalen—Dec. 1, 1903. No. 59844 D.

Shops.

McKee's Rocks Shops of the Pittsburg & Lake Erie. Illustrated detailed description of this large plant, which represents the most approved modern practice. 4800 w. Ry Age—Dec. 18, 1903. No. 59691.

Railroad Shop Management. William S. Cozad. Discusses in a general way the subject of shop organization and the relation which must exist between the management and the men before putting the shops on a satisfactory piecework basis. 2000 w. Am Engr & R R Jour—Dec., 1903. Serial. 1st part. No. 59397 C.

Signals.

Hall Electro-Gas Normal Danger Signals on the Union Pacific. Illustrated detailed description of an installation in Wyoming. 1200 w. R R Gaz—Dec. 18, 1903. No. 59707.

Signalling at Philippsburg and Easton. An illustrated description of the "all-electric" switch and signal plants at these adjoining places, recently installed on the Lehigh Valley Railroad. 2000 w. R R Gaz—Dec. 11 1903. No. 59521.

Southern Pacific Passenger Station at San Antonio. An illustrated description of a new passenger station in the Mission style of architecture. 600 w. R R Gaz—Dec. 18, 1903. No. 59706.

The Electric Method of Operating Switches and Signals (Les Appareils Electriques pour la Commande des Aiguilles et des Signaux). M. Rodary. A description of the system in use at the Paris terminal of the Paris, Lyons and Mediterranean Railway. 5000 w. Rev Gen des Chem de Fer—Dec., 1903. No. 59881 G.

The Westinghouse Electro-Gas Signal. Illustrated description of a signal in which carbon-dioxide gas, stored in a liquid form in small reservoirs, furnishes the power for the signal motor. 1200 w. Engng—Dec. 4, 1903. No. 59637 A.

Station.

The Washington Union Station. An illustrated description of a fine station, to cost not less than $4,000,000. 2000 w. R R Gaz—Dec. 4, 1903. No. 59489.

Tunnels.

See Civil Engineering, Construction.

TRAFFIC.

Demurrage.

The Doctrine of Demurrage. Editorial discussion of special statutes of different States modifying the general law. 2500 w. R R Gaz—Dec. 11, 1903. No. 59523.

Traffic Associations.

Railway Traffic Associations—Their Origin, Object and Results. C. E. E. Childers. Read before the Traffic Club of Pittsburg. Their aim to secure uniformity, stability and reasonableness of rates. 3000 w. Ry Age—Nov. 27, 1903. No. 59369.

We supply copies of these articles. See page 796.

MISCELLANY.

Fire Risks.

Fire Prevention of Railroad Risks. E. D. Sompayrae. Discusses the importance of preventing fires causing loss of railroad property. Cites cases due to carelessness, and suggests steps tending to the elimination of fires. 2300 w. Ry Age—Nov. 27, 1903. No. 59368.

Northern Securities.

The Northern Securities Case Before the United States Supreme Court. Abstracts of briefs and arguments setting forth both sides of the contention. The Government brought the suit upon the charge that the Sherman anti-trust law had been violated. 8500 w. Ry Age—Dec. 18, 1903. No. 59690.

Testing Plant.

The First Bulletin of the Pennsylvania Railroad's Testing Plant at St. Louis. Describes the work to be carried on with the locomotive-testing plant. 4000 w. R R Gaz—Dec. 4, 1903. No. 59490.

STREET AND ELECTRIC RAILWAYS

Alternating Currents.

Electric Traction with Alternating Currents. A. C. Eborall. Read before the Manchester Soc. of the Inst. of Elec. Engrs. Deals with some features incidental to the employment of three-phase currents for railway purposes, considering briefly the subject of single-phase railway motors. 4700 w. Elect'n, Lond—Dec. 18, 1903. Serial. 1st part. No. 59770 A.

Alternating Motors.

Alternating Motors for Railway Service. Louis Bell. Discusses recent designs in new equipment and the advantages of the alternating-current motor. 2000 w. St Ry Jour—Dec. 19, 1903. No. 59697 C.

Brakes.

Brakes for Electric Cars. W. Park. Outlines the principles governing the retardation of a moving car, describing and discussing the merits of the brakes in use, especially electric brakes. 3300 w. Tram & Ry Wld—Dec. 10, 1903. No. 59731 B.

Braking.

Motors as Emergency Brakes. Cale Gough. An explanation of the action that takes place. Ill. 900 w. St Ry Jour—Dec. 5, 1903. No. 59459 C.

Cable Railway.

The Mendel Railway (Die Mendelbahn). E. Strub. An account of the cable traction railway up the Mendel Pass in the Southern Tyrol. An altitude of 852 metres is surmounted with grades of 64 per cent. Three articles. 5000 w. Schweizerische Bauzeitung—Nov. 14, 21, Dec. 5, 1903. No. 59826 each B.

Employees.

The Methods of Handling the Men on the Camden & Suburban Railway. Gives in detail the methods followed and also the system of preparing time-tables, assigning runs, &c. Ill. 4000 w. St Ry Jour—Dec. 12, 1903. No. 59583 C.

Fare Register.

A New Fare Register. Illustrates and describes a device invented by W. I. Ohmer, which contains many new ideas. 2200 w. St Ry Jour—Dec. 12, 1903. No. 59586 C.

High Speed.

The Marienfelde-Zossen High-Speed Electric Railway Trials. Dr. A. Gradenwitz. A description of the road and the mechanism by means of which a speed of more than 130 miles an hour was attained. 4000 w. Engineering Magazine—Jan., 1903. No. 59884 B.

Improvements.

Improvements on a Kentucky System. An illustrated detailed description of recent improvements in the system of the South Covington & Cincinnati Street Ry. Co. 1700 w. St Ry Jour—Dec. 19, 1903. No. 59695 C.

Interrupter.

An Isolator Interrupter (Isolateur Interrupteur). A description of the Giraud device for supporting trolley or other overhead wires in such a manner that the current is cut off in case the wire is broken. 800 w. Génie Civil—Nov. 21, 1903. No. 59803 D.

Interurban.

Interurban Electric Traction Systems—Alternating Current vs. Direct Current. P. M. Lincoln. Read before the Canadian Engrs'. Soc. Discusses the principal advantages of the alternating-current-electric traction over the direct current, comparing the two systems. 6000 w. St Ry Jour—Dec. 12, 1903. No. 59587 C.

New Interurban Railway in Switzerland. Henri Somach. Brief illustrated description of the line between Wetzikon and Meilen. 800 w. St Ry Jour—Dec. 26, 1903. No. 59918 C.

Ipswich.

The Electric Tramways of Ipswich.

We supply copies of these articles. See page 796.

Illustrated description of a new tramway system, the peculiarities are the great size of the power station buildings compared with present requirements, and the use of double-track in narrow streets. 3500 w. Tram & Ry Wld—Dec. 10, 1903. No. 59728 B.

Japan.

The Elevated Railway of Tokio (Die Hochbahn von Tokio). F. Baltzer. A very full account of the construction and equipment of the elevated railway in Tokio, Japan. Serial. 1st part. 4000 w. Zeitschr d Ver Deutscher Ing—Nov. 21, 1903. No. 59810 D.

Light Railway.

The Portsdown and Horndean Light Railway. John R. Hewett. Illustrated description of an English electric line, running from a large town into a rural district. 3600 w. Trac & Trans—Dec., 1903. No. 59631 E.

Mountain Railways.

Mountain Climbing Railways. George E. Walsh. Briefly considers the railways of Mt. Washington, Pike's Peak, Mt. Pilatus, and the Jungfrau. 2400 w. Elec Rev, N. Y.—Dec. 26, 1903. No. 59917.

Multiple Supply.

The Multiple Supply Electric Railway System for Heavy Traffic. W. N. Stewart. On the Edison storage battery and its application to railway trains. 1500 w. Tram & Ry Wld—Dec. 10, 1903. No. 59730 B.

Multiple-Unit.

The Siemens-Schückert Multiple Unit System of Electric Train Control. Emile Guarini. Illustrated article explaining a mixed system in which electricity serves only for the operation of compressed-air valves. 1400 w. Elec Rev, N. Y.—Dec. 19, 1903. No. 59677.

Paris-Versailles.

The Paris-Versailles Electric Railway. Daniel Bellet. An illustrated detailed description of the new route, Invalides-Versailles, its construction, equipment, &c. 5800 w. Trac & Trans—Dec., 1903. No. 59630 E.

Pittsburg.

I. Notes on Rapid Transit with Special Reference to Pittsburg. Emil Swensson. II. The Effect of Multiple Control on the Traction Problem of Pittsburg. N. W. Storer. Two papers discussed together. 17800 w. Pro Engrs' Soc of W Penn—Nov., 1903. No. 59792 D.

Railway Motors.

The Electric Motor as a Railway Motor (Der Elektromotor als Eisenbahnmotor). J. Szasz. A comparison of the relative advantages of continuous and single-phase motors for railway service. 1800 w. Zeitschr f Elektrotech—Nov. 22, 1903. No. 59865 D.

Records.

Daily Reports, Store Room Accounting and Operating Records of the Camden & Suburban Railway. Gives interesting blanks used and explains the system. 3800 w. St. Ry Jour—Dec. 19, 1903. No. 59696 C.

Repairs.

Repair Shop Practice on the Camden & Suburban Road. Illustrates and describes the shops and explains the system in use. 2200 w. St Ry Jour—Dec. 26, 1903. No. 59919 C.

Signals.

Alternating Current for Signaling on Interurban Electric Railways. An account of the demonstrations at Rochester, N. Y., of the automatic block signaling system of S. Marsh Young. Ill. 3000 w. St Ry Jour—Dec. 26, 1903. No. 59921 C.

A Track Circuit Block Signal for Electric Railways. Describes a system recently demonstrated at Rochester, N. Y. 2000 w. Eng News—Dec. 24, 1903. No. 59797.

Single-Phase.

Application of Single-Phase Alternating-Current for Traction and Railway Service. B. G. Lamme. Discusses the commutator type of single-phase motors and their advantages. Also editorial. 6700 w. St Ry Jour—Dec. 26, 1903. No. 59920 C.

The Winter Eichberg Single-Phase Railway System. Illustrates and describes some of the features of this motor as given in the English patent, with remarks on the system. 1100 w. Elec Wld & Eng—Dec. 19, 1903. No. 59698.

South Africa.

Durban (S. Africa) Electric Light and Tramways. Illustrated description of the new combined power plant which is to supply this seaport of Natal. 2000 w. Elec Rev, Lond—Dec. 11, 1903. Serial. 1st part. No. 59752 A.

Stray Currents.

Investigations of Stray Currents in the Street Railways of Geneva (Untersuchungen über Vagabundierende Ströme auf den Strassenbahnen in Genf). L. Thormann. An examination of the electrolytic corrosion of buried pipes by the action of stray currents from the electric tramways. 2000 w. Schweizerische Bauzeitung—Nov. 28, 1903. No. 59827 B.

Train Control.

Electric Train-Control Systems (Elektrische Zugsteuerungen). Dr. F. Niethammer. Discussing the multiple-unit systems of Siemens & Halske, Sprague, Westinghouse, Schuckert, and others. Two articles. 6000 w. Zeitschr f Elektrotech—Dec. 6, 13, 1903. No. 59869. Each D.

We supply copies of these articles. See page 796.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.

Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* New York.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Enginering and Mining Journal. *w.* New York.
Enginering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Feilden's Magazine. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Württ. Ver. f. Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Pacific Coast Miner. *w.* San Francisco.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wiener Bauindustrie Zeitung. *w.* Vienna.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Electrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Commutators.

Commutator Construction. By William Baxter, Jr. Size, 8 by 5½ in.; pp. 23; figures, 39. Price (paper), 25 cents. New York: The Derry-Collard Co.

The commutator is only a small part of a dynamo or motor, but if it is not well made it may disorganize the whole machine, and its careful construction becomes, therefore, of the greatest importance. In this little book, which is the third number of a series of papers published by the Derry-Collard Co., there is much plain and practical advice on the construction and the repair of commutators. The illustrations are clear, and the pamphlet, which is attractive in appearance, will prove instructive and useful to those who are concerned with the making and the maintenance of a vital part of all direct-current electrical machines.

Electrical Engineering.

Electrical Engineering, An Elementary Text-Book Suitable for Persons Employed in the Mechanical and Electrical Engineering Trades, for Elementary Students of Electrical Engineering, and for All Who Wish to Acquire a Knowledge of the Chief Principles and Practice of the Subject. By E. Rosenberg. Translated from the German by W. W. Haldane Gee and Carl Kinsbrunner. Size, 9¼ by 6 in.; pp. xiii, 267; figures, 263. Price, $1.50. New York: John Wiley & Sons. London: Harper Brothers.

At this late day, a new book on elementary electrical engineering must have some decidedly strong features to justify its publication, and to enable it to prove a useful addition to the mass of such literature. These useful qualities the present work possesses, partly on account of the way in which it originated and partly owing to the manner in which it has been carried out. The book had its origin in a number of lectures delivered by the author to the workmen and the staff of a large electrical manufacturing firm, and follows the general lines of these addresses. It is, therefore, in plain and simple style, and very little, if any, mathematics is required for its understanding. It is also the work of an electrical engineer engaged in active manufacturing operations, and is written from an engineering standpoint. After laying down the fundamental principles of electric currents and magnetism, the description of electrical apparatus is begun, and the various branches of "heavy-current" electrical engineering are taken up. The treatment of alternating currents and alternating-current apparatus, both single- and polyphase, is especially full for a work of this kind, and at the same time is remarkably direct and clear. Among the subjects discussed in the different chapters are the continuous-current dynamo, the electric motor, accumulators, the working of dynamos in parallel, electric lighting, alternating currents, alternators, alternating-current motors, polyphase alternating currents, and high-tension currents. The books is very well and intelligently translated, and is clearly illustrated, and it will undoubtedly prove very helpful to students of electrical engineering and electrical workmen in particular, and to seekers after an understanding of electrical engineering in general.

Electric Railways.

Notes on Electric Railway Economics and Preliminary Engineering. By W. C. Gotshall. Size, 9 by 6 in.; pp. v, 251; many illustrations and diagrams. Price, $2. New York: McGraw Publishing Co.

The purpose of this book is to consider the subject of interurban electric railroading, "broadly and as a whole, to outline the work of the electric railway engineer during the inaugurative and constructive period of a proposed road, and to give in a general way some bases upon which the costs of construction, probable present and future traffic, and ultimate economic results of the proposed railway can be gauged." The book is based upon a series of lectures delivered at Lehigh University, the lecture notes having been filled out and rearranged so that the topics treated follow the order in which they would be taken up in the actual investigation and construction of an electric railway. After the introduction, the chapters are devoted, respectively, to preliminary office determinations; preliminary field survey; detailed office investigations of track location; preliminary determination of schedules and equipment; estimate of earnings;

estimate of probable operating expenses; the final survey; track construction; overhead or third-rail construction; the power station; storage batteries; rolling stock and motors; securing rights of way; preparation of the specifications; the construction period; organization of the operating department; and economic considerations. An appendix contains a set of complete specifications for the construction and equipment of a moderate-sized, high-speed, interurban electric railway, and another appendix contains a list of some articles on interurban electric railway work which have appeared in technical journals. Throughout the book, particular emphasis is laid upon the commercial and financial aspects of electric railways, although the engineering features are by no means lost sight of. The author states that "the controlling features required for the success of high-speed interurban railways in the order of their importance are: First, safety to the public and the employees of the railroad; second, reliability of operation; third, convenience and comfort of the public; fourth, minimum cost of operation and maintenance." In developing his subject, the author draws largely upon his extensive practical experience, and, in particular, liberal use is made of the data obtained in the construction of the New York and Port Chester Railroad, of which he is president and chief engineer. Altogether the work contains a very common sense and practical treatment of a most important subject, and will be of great value to anyone interested in electrical railways, either from the financial or the engineering standpoint.

Electrochemistry.

Kalender für Elektrochemiker sowie Technische Chemiker und Physiker. 1904. By Dr. A. Neuburger. Size, 6¼ by 4¼ in.; pp. xxxv, 575 (supplement, pp. 416); many figures. Price, $1.25. Berlin: M. Krayn.

Electrochemistry is already such an important science, as well as industry, touching, as it does, so many fields of technical activity, and is making such rapid advances, that there is abundant justification for the publication of an annual handbook such as the present work. This is the eighth year of its issue, and it has grown so that a supplementary volume, nearly as large as the original, is necessary to hold the abundant and varied contents. While similar in general appearance and arrangement to the 1903 edition, the present issue has been revised and brought up to date and new matter has been added, among which may be noticed descriptions of the Edison and the Jungner accumulators and a compilation of practically all the better known electro-metallurgical processes for the preparation of steel direct from the ore. The work is far more than a calendar, as it contains a great many tables, illustrations and descriptions of both laboratory and manufacturing processes, the patent laws of many countries, and a great quantity of electrical, chemical and physical data which make it a handy encyclopedia of electrochemistry and its allied industries.

Machine Design.

Machine Design. Part I: Fastenings. By William Ledyard Cathcart. Size, 9½ by 6 inches; pp. xi, 291; figures, 122. Price, $3. New York: D. Van Nostrand Company.

Machine design has been the subject of some able treatises, but as the art is continually advancing, there is need, from time to time, for new works on it, which will record and discuss the latest improvements. Such is the function of the present book, which is concerned particularly with modern American practice in the branch of machine design indicated by the title. The theoretical treatment of the subject has been given fully, and in some cases it is shown how formulae, which are merely stated in the older treatises, are derived. The principal part of this work, however, is its account of the practical developments that have recently taken place, with its discussion of the resulting data. The book is divided into the following parts: Shrinkage and pressure joints; screw fastenings; riveted joints, theory and formulae; riveted joints, tests and data from practice; keyed joints and pin joints. In the chapter on screws, all the standard threads in the United States, in Great Britain and on the Continent of Europe, are fully described, and formulae and tables of them are given. Throughout the book there are many tables and various eminent authorities are cited; there is an index, and altogether the work is a very interesting contribution to the science and the art of machine design, and will be of great value to the student and the designer.

Mechanical Engineering.

The Mechanical Engineer's Reference Book. A Hand-Book of Tables, Formulas and Methods for Engineers, Students and Draftsmen. By Henry Harrison Suplee, B. Sc., M. E. Size, 6¾ by 4¼ in.; pp. xii, 830; fully illustrated. Price, $5 (with thumb index, $5.50). Philadelphia and London: J. B. Lippincott Company.

In most of the engineering hand-books that have been published, a mass of data and a variety of rules are given, and the reader is left to make his own choice, but in this volume, while the principal authorities are quoted, the best rule or formula for a given case is pointed out, or directions are given so that the seeker for information can make an intelligent

selection. The field of engineering has widened so greatly that it is impossible to condense all the information essential for engineers in general within the limits of a hand-book or pocket-book, so that a book of this kind must necessarily be confined to one branch of engineering, but the present work, while its specialty is mechanical engineering, also gives valuable tables and data concerning some of the allied branches, such as electrical and marine engineering. The volume is intended to be a successor to the well-known pocket-book written many years ago by the late John W. Nystrom, but the latter's work has served principally as a foundation for a most modern and up-to-date structure. The early tables have been carefully overhauled and many new ones have been added, among the latter being what is probably the first one published for finding the exact perimeter of an ellipse. The metric system receives due recognition, some of the tables—notably those on the properties of steam—being given in both the English and the metric systems, each complete in itself and both in the same form, so that comparisons may be made conveniently. The latest as well as the best authorities have been freely drawn upon, and the results of the most recent investigations have been used in the preparation of this book, so that the engineer who consults it need have no fear of being behind the times. A complete index makes the finding of information easy, and in material and workmanship the book leaves nothing to be desired, being convenient in size, well and attractively bound, and clearly printed on good paper.

Mill Buildings.

The Design of Steel Mill Buildings and the Calculation of Stresses in Framed Structures. By Milo S. Ketchum, C. E. Size, 9 by 6½ in.; pp. xiii, 367; figures, 185. Price, $4. New York: The Engineering News Publishing Co.

Mill, or shop, buildings have become such an important class of framed structures that there is ample room for a treatise on their design and construction. Such is the purpose of the present book, which describes the different kinds of steel mill buildings in common use and goes into the details of their construction. Closely interwoven with the main subject is the calculation of stresses in framed structures, which receives a systematic and adequate treatment. Both the algebraic and the graphic methods of calculating stresses are fully described and illustrated. Each step in the solution is explained and analyzed so that the reader will get a definite idea of the underlying principles. In the discussion of mill buildings, the methods of construction and the materials used are described, together with the design of the structures and the making of estimates of weight and cost. Methods, data and details not ordinarily available are given, and the matter is presented in a way to assist the engineer in making his designs and the detailer in developing them in the drawing room. The author is guided by his experience both as a designing engineer and contracting agent and as a professor of civil engineering at the University of Illinois, so that the book is thoroughly practical and at the same time presents its subject in a systematic and orderly manner, with due attention to fundamental principles. It will, therefore, be of great value both to the designing engineer and to the engineering student.

Space Telegraphy.

Wireless Telegraphy; Its Origins, Development, Inventions and Apparatus. By Charles Henry Sewall. Size, 8¼ by 5¾ in.; pp. 229; diagrams and illustrations, 85. Price, $2. New York: D. Van Nostrand Company.

Space, or wireless, telegraphy, although a young art, is growing very rapidly, as it possesses a peculiar fascination for the engineer and inventor, and appeals powerfully to the imagination of the general public. Patent offices are crowded with applications, and although only a small part of the new devices have been tried on a commercially practical scale, the valuable work already accomplished in the domain of wireless telegraphy and the great interest shown in it assure the art a bright, and probably a brilliant, future. At this stage, where there has already been so much individual effort and where so many "systems" are in the field, it is of special importance to have the fundamental principles laid down and to have the various devices analyzed and classified. Such is the aim of the present work, and although the arrangement and systematized treatment of the material leaves something to be desired, which is partly due to the inherent difficulty of the subject, the book contains a large amount of valuable and interesting matter. There is a general history of wireless telegraphy, with particular accounts of the work of the men who have been chiefly instrumental in advancing the art. The leading inventions are described, and the principal patents are examined and analyzed, some of the chief claims and a few of the most important specifications being given in full.

BOOK RECEIVED.

Experimental Researches on Reinforced Concrete. By Armand Considère. Translated and arranged by Leon S. Moisseiff, C. E. Price, $2. New York: McGraw Publishing Co.

IMPROVED MACHINERY

New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

An Automobile Road Train.

A NOVEL and interesting system for the transportation of goods along roads and in regions where railroads do not exist, and hauling is done slowly and expensively by horses or mules, has recently been developed by the Gibbs Engineering and Manufacturing Company.

This transportation system comprises a tractor-drawn or automobile road train, consisting of a tractor, carrying an electric generating set, and self-propelling trail cars, whose motors are supplied with current by the dynamo on the tractor.

GIBBS AUTOMOBILE ROAD TRAIN.

In its general appearance, the tractor resembles an electric locomotive. It has a central compartment containing the gasoline engine, the controlling apparatus and a stand for the engineer, while the electric machines are placed in the forward and rear compartments with sloping tops. The total weight of one of these tractors, to be used with a train of two cars, is 6 tons, with supplies on board; the wheel base is 6 feet and the gauge is also 6 feet. The diameter of the driving wheels is 36 inches, and of the steering wheels 32 inches; the solid rubber tires of the drivers have a width of 7 inches, and those of the steering wheels, 3½ inches.

This tractor is driven by two six-horse-power, series-wound, 220-volt, electric motors, which draw their current from the 30-kilowatt, 220-volt, direct-current generator, which, in turn, is driven by a 40-horse-power gasoline engine, with three cylinders.

The capacity of the gasoline tank, carried on the tractor, is about 30 gallons, and that of the water tank, 50 gallons.

Each trail car has a tare weight of 2½ tons, a wheel base of 10 feet and a gauge of 6 feet 9 inches. The driving wheels are 56 inches in diameter, and the steering wheels, 38 inches. All the wheels have steel tires, 5 inches wide. The capacity of each trail car for paying load is 10 tons, and the area available for loading is 16 feet 3 inches by 5 feet 6 inches. These trail cars are each driven by two 5-horse-power motors, to which current is conducted from the generator on the tractor by means of flexible connections. As the trail cars and the tractor are coupled together, the latter's tractive effort helps to move the entire train.

The whole train is constructed in a most substantial manner, and is operated by means of a controller on the tractor.

The train which has just been described and which is shown in the accompanying illustration, has been constructed for the Massey Station Mining Company, of Canada. Another train, built on the same general lines, but consisting of seven trailers, each of 15 tons capacity, with a tractor having a gasoline engine of 125 horse-power, is destined for California, where it will be used to transport borax a distance of about 125 miles across the Mojave Desert from a deposit belonging to the Pacific Coast Borax Company in Death Valley.

It can readily be seen that such trains of self-propelling cars, attached to what is practically a portable power station, possess peculiar advantages for the transportation of heavy commodities in regions which are inaccessible to railroads, and they will undoubtedly be largely used for this and similar work. Further information concerning this system will be gladly furnished by the Gibbs Engineering and Manufacturing Co., of Glendale, Long Island, N. Y.

REEVES REVOLVING GOVERNOR BEARING.

The Reeves Automatic Revolving Governor Bearing.

SENSITIVE and close regulation of an engine can only be obtained by keeping the pin upon which the governor arm hangs constantly and thoroughly lubricated, and as the greatest pressure which this pin exerts upon its bearings always comes in very nearly the same place, the tendency is to force out the lubricant and wear the bearing surfaces to such an extent that sometimes the governor does not perform its intended functions at all.

The Reeves automatic revolving bearing device enables this important difficulty to be entirely overcome, and, in addition, gives more perfect continuous regulation than has ever before been obtained with a Rites governor.

The accompanying illustration shows the hub of the governor wheel with the automatic revolving bearing partially assembled. The holes for the shaft and governor pin are bored at the same setting, thereby assuring perfect alignment, then a hard cast iron bushing, which has been carefully reamed and ground, is pressed into the cavity that is to carry the pin.

Into this bushing is introduced a carefully finished gun metal sleeve, constructed with connected lubricating grooves, on the inside and the outside, around and lengthwise of the sleeve, and by means of the grooves the lubricant, which is supplied by force-feed grease cups, is carried to all the bearing surfaces.

The governor is now attached to the wheel by inserting the pin, through the gun-metal sleeve. The shoulder, on the bar, will face the finished surface on the back of the wheel and the end of the pin will come flush with the face of the sleeve on the front and be held in place by the cap, as shown in the illustration.

There is a pawl on the cap, and teeth are cut into the rim of the sleeve. When the cap is in place it must move with the pin, since it is securely held by a dowel and stud bolt.

It can now be clearly seen that when the governor arm moves away from the stop on the rim of the wheel, as it is sure to do when the engine is started, that the pawl on the cap will pick up a tooth, and turn the sleeve a short distance (always in the same direction), and when the arm moves back another tooth will be engaged and the operation repeated, thereby presenting continuously to the pin a freshly lubricated and practically a new bearing surface.

This insures constant lubrication and practically perfect continuous regulation. Any wear that may occur, takes place on the revolving sleeve and this being interchangeable, can be replaced, when necessary, in a very few minutes.

This is an illustration of the extent to which the refinements of all the parts of the Reeves engines have been carried, any further information concerning which will be gladly given by the Reeves Engine Company, of 83 Liberty St., New York.

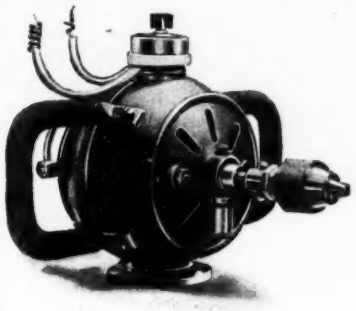
A Small Portable Electric Drill.

THE adaptability of the Sprague Electric Co.'s small motors to high class work has enabled that company to meet the demand for a portable drill that will be not only convenient to handle but also efficient and reliable in operation.

This drill is made in two sizes, namely, 1/20 and 1/10 horse-power, and operates at approximately 1,000 revolutions per minute.

The outfit consists of a small round type motor, with two substantial handles attached to its frame, for holding it while in operation. The motor shaft is fitted with a standard adjustable chuck, capable of receiving small drills from any size up to and including 5/16 of an inch.

These portable drills have been found very successful for drilling holes in the large slate or marble panels used for switch-



SPRAGUE PORTABLE ELECTRIC DRILL.

boards, and also for drilling steel, cast-iron and wood, which work is done much more rapidly than by the ordinary hand breast drill.

It has been found from experience that these portable electric drills save a considerable amount of time and labor where small holes are to be drilled in iron or steel frames, and also in switchboards which have already been assembled, as it is possible to take the drill to the work instead of being

SPRAGUE ELECTRIC DRILL AT WORK.

under the necessity of dismantling the apparatus in order to carry it to the ordinary stationary machine drill.

Further information concerning these handy little machines will be cheerfully furnished by the Sprague Electric Co., of 527-531 W. 34th St., New York.

Electric Gantry Traveling Crane.

A FIVE-MOTOR, double-trolley, electric gantry traveling crane, of 50 tons capacity, has been recently installed in the yards of the Vermont Marble Co., West Rutland, Vermont.

The crane is equipped with two trolleys, each of 25 tons capacity. The distance between the truck frames which support the bridge is 60 feet and the overhang of each cantilever arm, 50 feet. The total length of the bridge is therefore 160 feet. It has a maximum capacity of 50 tons in the middle of the span and the cantilever arms are designed to support a 10-ton load each, with the trolley at the extreme outside position. The height of lift for each hoist is 30 feet.

All movements are operated by independent electric motors especially designed for

crane service. Speeds for maximum loads are as follows: Hoist, 15 feet per minute; trolley travel, 100 feet per minute; bridge travel, 150 feet per minute.

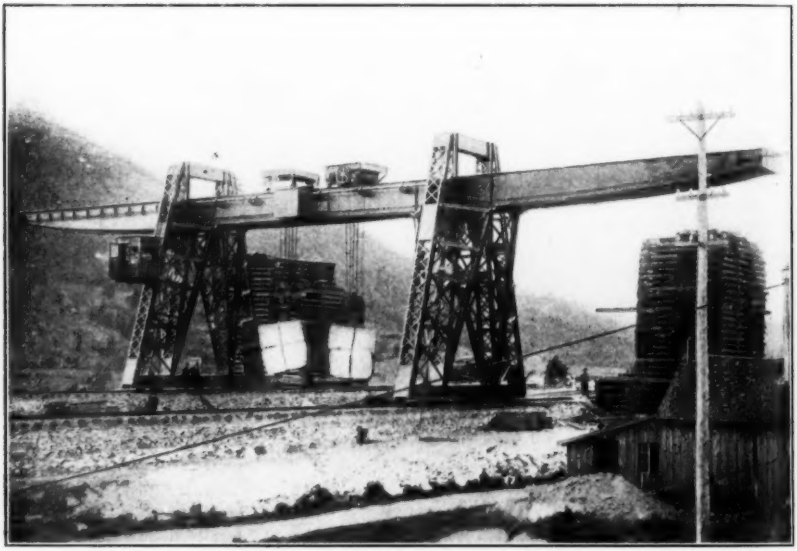
The trolleys and bridge motor and mechanism are covered and the cage is enclosed for outdoor service.

The current for this crane is supplied by trolley wires at one end and above the crane and is carried to the crane by means of a harp and collector wheel according to the method used in street-car service.

The connections to the bridge girders cover a distance of 17 feet. Both truck frames are open to permit the load to pass through them. They terminate at the bottom in built-up girders, each carrying two cast-steel pivoted trucks, which permit of vertical movement to provide for inequalities of the track. The wheels are fitted with double flange rolled steel tires; they are eight in number, four under each end of the crane. The four wheels under each end are in two sets, one set under each truck.

A railroad track runs midway between the two tracks on which the gantry operates. Marble blocks will be taken from cars on this track and stored, and also will be delivered from the yard to cars. The space covered is 160 feet wide and 600 feet long. Two of the company's marble quarries are at the right of the picture.

The gantry crane will take the place of seven derricks with which the old yard is equipped. As each derrick required one man, seven in all, and the gantry needs only one man for manipulation, the saving is apparent; besides, the gantry crane is much more economical of space and can handle loads with much greater rapidity. The illustration shows loads of about 25 tons on each trolley.



WHITING ELECTRIC GANTRY TRAVELING CRANE.

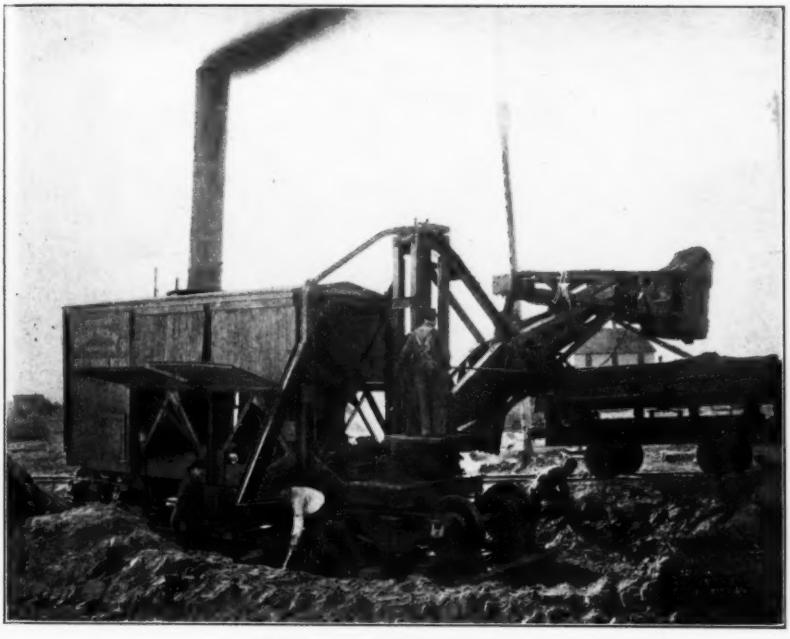
This crane was manufactured by the Whiting Foundry Equipment Co., of Harvey, Ill., near Chicago, by whom any further information desired will be gladly furnished.

Kilgore Steam Railway Shovel.

STEAM shovels in the past have generally been built on the hoisting-engine principle, which necessitates having a great deal of chain and a large amount of machinery, with many parts which are liable to injury, so that such shovels often get out of order and have to be laid up for repairs, thereby entailing heavy losses in time and money.

With the Kilgore direct-acting steam railway shovel, on the contrary, no chains, chain sheaves, winding drums, friction clutches, gears, hoisting engines, or cables are used. All small parts are eliminated, and all the machinery is direct-connected and direct-acting. All movements of the dipper are controlled by four powerful direct-acting steam cylinders having light balanced valves operated by two easy-moving hand levers, giving many desirable motions to the dipper unattainable in any other shovel. The engineer holds one lever in each hand, and the dipper responds instantly to every motion of the lever, quick or slow, and moves in the direction his hand moves. The direct-acting principle as applied to the swing gives a very speedy motion and also permits of perfect control. The engineer's platform swings with the dipper, giving him an unobstructed view of the latter at all times and enabling him to dump the dipper load where desired by means of a steam cylinder operated by a foot lever. This permits him to handle the shovel in the most effective manner. While the movements are all very powerful, the machine responds to the levers instantly and is always under the perfect control of the operator.

The dipper can be shaken violently to toss off the sod or any large boulders too big to pass through the dipper opening, or to clear itself of sticky clay. By working two pistons at once the dipper can be moved in a direct line to the point desired. The dipper can dig in all kinds of materials, nose around a root or rock, reach beyond it to pull it back, pick it up, move in a direct line to the dumping point, and toss it out over the top of the dipper if necessary. These shovels, all set up, conform to standard railroad clearances, and so no change is necessary for shipment. The shovel is self-propelling, and can be transported to and operated in places where large shovels cannot be used.



KILGORE STEAM RAILWAY SHOVEL.

These machines are built almost entirely of steel and are very strong, rigid and powerful. Further information concerning them may be obtained from the manufacturers, the Kilgore Machine Co., Minneapolis.

Electric Hack Saw.

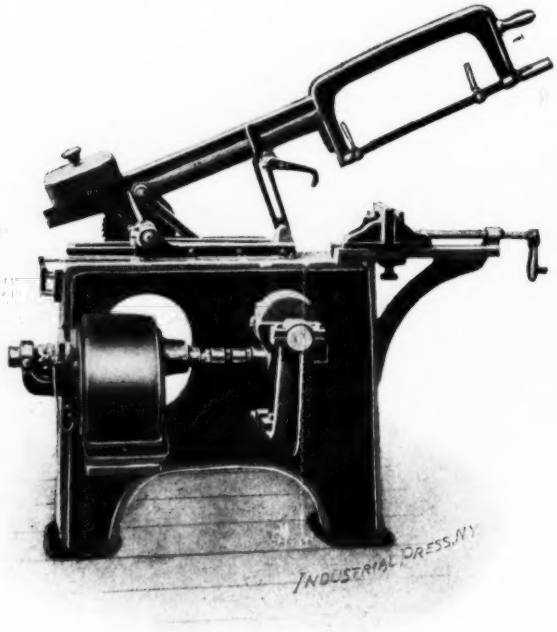
ANYBODY who carries iron and steel bars and other shapes in stock feels the necessity for a convenient machine for cutting his material to any size required, and on all such persons the "Challenge" power hack saw will make a strong and favorable impression.

The accompanying illustration shows one of these saws for cutting 6-inch by 6-inch shapes, driven by a ¾-horse-power high-speed electric motor, the speed being reduced to 40 strokes per minute on the saw, through the medium of the worm gearing in an oil case. No starting box is necessary, the saw being started by throwing in the knife switch attached to the back of the machine, and automatically stopped when the cut is finished.

This hack saw appeals especially to iron and steel merchants who have electric current in their warehouses. The illustration was made from a saw which has been thus located for three years.

The machine is fitted with a patented device for giving the saw an adjustable force feed. The result is that an equal amount of energy is expended in relieving the saw on the return stroke, thereby preventing any drag, and consequently prolonging the life and efficiency of the saw blade. This saw is also made so as to be belt driven, and either this style or the motor-driven one can be fitted with a high frame for cutting 6 inches by 12 inches, thus making the machine valuable for work on structural shapes.

Further information concerning this interesting machine will be gladly furnished by the manufacturers, The Patterson Tool and Supply Co., of Dayton, Ohio.



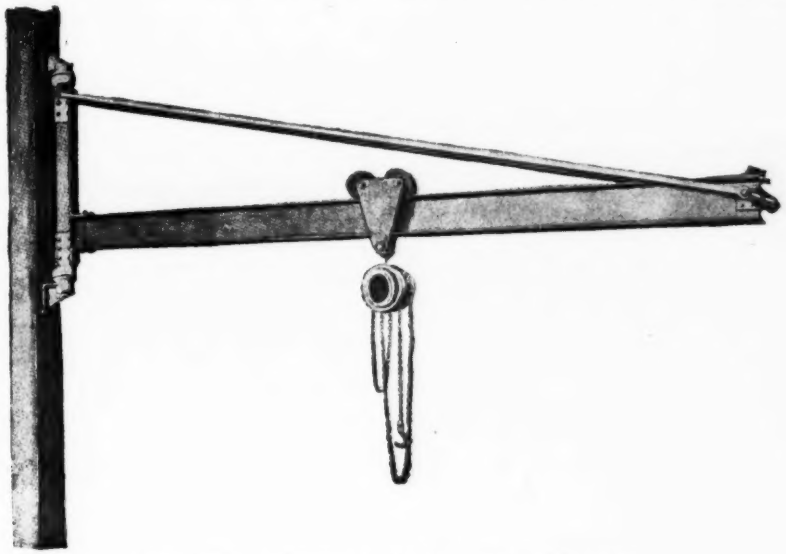
PATTERSON ELECTRIC HACK SAW.

A New Post Crane.

A POST crane which has been recently placed on the market, and which was designed to meet the demand for a light, inexpensive crane for foundries, erecting and

assembling shops, serving machines, and other uses, is shown in the accompanying illustration, which gives a good idea of the general construction.

The bearings at top and bottom of the mast are of the caged roller type, and the downward thrust is taken up by a bronze plate between two hardened steel plates. The trolley is roller bearing and can be furnished to run either on the top or bottom flanges of the I beam. If desired, a geared trolley can be furnished for racking with hand chain. The tie rods are so spaced as to allow a maximum trolley travel, the wheel stop being at the end of the jib, as shown.



NEW JERSEY FOUNDRY & MACHINE CO.'S POST CRANE.

These cranes are easily put up, the bracket bearings being bolted to a post, column or wall as desired. By a slight variation in the construction of the brackets and bearings, the crane can be lifted from the sockets and transferred to other duplicate sockets placed at desired points, thus covering a large floor space with one or more cranes. Though these cranes have been on the market but a short time, there is already a large demand for them, the call being mostly for those of one ton capacity, with 15 feet trolley travel, but they can be furnished up to 5 tons capacity, with 20 feet trolley travel.

The manufacturers of this crane, the New Jersey Foundry & Machine Co., of 9 and 15 Murray St., New York, also build travelling, jib, I-beam, locomotive and gantry cranes, and elevating and conveying machinery, and will be glad to furnish any more information that may be desired.

High-Power Westinghouse-Parsons Steam Turbines.

THE inauguration of the present century is marked by no more conspicuous event in American industrial development than the commercial introduction of the steam turbine for general power service.

The Westinghouse-Parsons steam turbine was commercially introduced during the closing months of the last century. The sizes then built were of 600 horse power nominal capacity, direct connected to 400-kilowatt polyphase generators. Subsequent development has been so rapid that within a period of four years turbines of 5,500 kilowatts, or 7,500 horse power, nominal capacity, have been designed and are under construction. These machines will have a continuous overload capacity of

11,000 horse power in one self-contained unit, and thus rank among the world's largest prime movers.

Recently, marine work has been contemplated by the builders and the near future may be productive of turbines of still greater power, although of slightly different arrangement, necessary to adapt the present type to marine usage.

The 5,000-kilowatt turbo-generating unit illustrated herewith is representative of the general type which will be constructed for large powers. This type embodies the experience acquired in the construction and operation of a large number of machines. The principle of operation as well as the general relation and arrangement of rotating and stationary elements characteristic of former types has been employed.

The most distinguishing features of the new type are the extreme compactness and low speed secured. These features have been practically prescribed by the necessity of minimizing the cost of power building construction for larger station capacities.

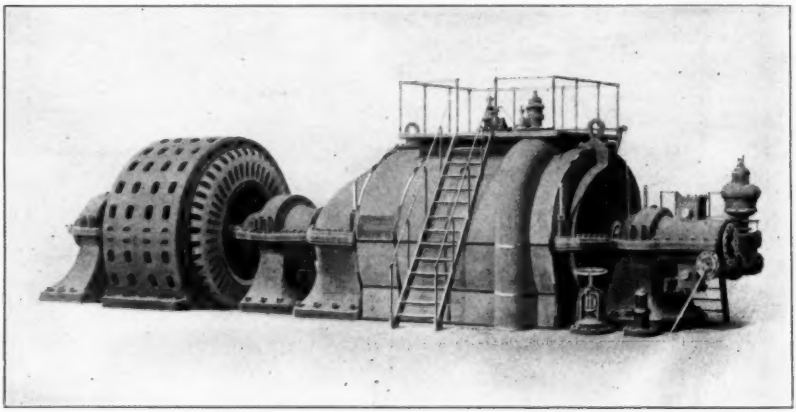
The space occupied by the 7,500-horse-power turbine is approximately 27 feet 8 inches by 13 feet 3 inches, and the height to the top of the hand-railing is 12 feet. This is equivalent to .049 square feet (less than one-twentieth of a square foot) per electric horse power capacity, or 20.2 horse power per square foot of floor area required.

For the complete unit a rectangular area of 47 feet 4 inches in length and 13 feet in width is required, which is equivalent to .084 square foot per electrical horse power capacity, or 12 electrical horse power per square foot of floor space.

In point of speed, the new type fulfils the demand for a unit operating at moderate speed. The 5,000-kilowatt units operate at 750 revolutions per minute, the 2,000-kilowatt unit at 1,200 to 1,560 revolutions per minute, and the 1,000-kilowatt unit at 1,500 to 1,800 revolutions per minute, depending upon the frequency desired.

The 5,000-kilowatt turbo-generating units here illustrated will be employed in heavy electric railway service, which is the most exacting encountered in central station operation. These machines will form the initial equipment of the Pennsylvania Railroad Terminal property in New York City, operating with electric locomotives the heaviest Pullman trains through the tunnel approaches to Manhattan. Three units will similarly inaugurate the power service on the Philadelphia Rapid Transit Subway system now under construction. Eight 5,000-kilowatt units will furnish power to the London Subway system, and three 3,500-kilowatt units to the surface system of the same city. These units will operate under 175 pounds steam pressure, high vacuum and 100 to 175 degrees of superheat.

Further information concerning these machines will be cheerfully furnished by the Westinghouse Machine Co., of Pittsburg.



WESTINGHOUSE-PARSONS TURBO-GENERATING SET.

NEWS SUPPLEMENT

The Engineering Magazine—February, 1904

Coming Society Meetings.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Sec.: Ralph W. Pope, 95 Liberty St., New York. Next meeting, Feb. 26, at Chemists' Club, 108 W. 55th St. Papers on Power Transmission. Annual dinner, Feb. 11, at Waldorf-Astoria.

AMERICAN INSTITUTE, POLYTECHNIC SECTION. Sec.: George Whitefield, Jr., 19 W. 44th St., New York. Meetings on first and third Thursdays of each month, from October to May, inclusive.

AMERICAN RAILWAY ASSOCIATION. Sec.: W. F. Allen, 24 Park Place, New York. Next meeting, April 27, at New York.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION. Sec.: L. C. Fritch, Monadnock Block, Chicago. Annual meeting, March 15-17, at Chicago.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 27-29, Saratoga Springs, N. Y.

AMERICAN SOCIETY OF CIVIL ENGINEERS. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month, except July and August.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Sec.: Prof. F. R. Hutton, 12 W. 31st St., New York. Next meeting in May, at Chicago.

ARCHITECTURAL LEAGUE OF AMERICA. Sec.: J. B. Nettleton. Next meeting, April or May, at Pittsburg.

BOSTON SOCIETY OF CIVIL ENGINEERS. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except July and August.

BROOKLYN ENGINEERS' CLUB. Sec.: J. Strachan, 191 Montague St. Regular meetings on second Thursday of each month.

CANADIAN RAILWAY CLUB. Sec.: W. H. Roseyear, Jr., Montreal. Regular meetings on first Tuesday of each month, except June, July and August.

CANADIAN SOCIETY OF CIVIL ENGINEERS. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. The General Section and the Electrical, Mechanical and Mining Sections meet on different Thursdays.

CENTRAL RAILWAY CLUB. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Friday of January, March, May, September, and November, Hotel Iroquois, Buffalo.

CHICAGO ELECTRICAL ASSOCIATION. Sec.: W. B. Hale, Monadnock Building. Regular meetings on first and third Fridays of each month, from October to May.

CIVIL ENGINEERS' CLUB OF CLEVELAND. Sec.: Joseph C. Beardsley, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS. Sec.: J. F. Jackson, New Haven. Annual meeting, Feb. 9 and 10, at Hartford.

ENGINEERING ASSOCIATION OF THE SOUTH. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block.

ENGINEERS' CLUB OF CHICAGO. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

ENGINEERS' CLUB OF CINCINNATI. Sec.: J. F. Wilson, P. O. Box 333. Regular meeting on third Thursday of each month, except July and August.

ENGINEERS' CLUB OF COLUMBUS (OHIO). Sec.: H. M. Gates, 12½ North High St. Regular meetings on first and third Saturdays of each month.

ENGINEERS' CLUB OF MINNEAPOLIS. Sec.: Jas. B. Gilman, American Bridge Co. Regular meetings on third Monday of each month.

ENGINEERS' CLUB OF PHILADELPHIA. Sec.: J. O. Clarke, 1122 Girard St. Regular meetings on first and third Saturdays of each month, except July and August.

ENGINEERS' CLUB OF ST. LOUIS. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays of each month.

ENGINEERS' SOCIETY OF WESTERN NEW YORK. Sec.: H. B. Alverson, 533 Ellicott Square, Buffalo. Regular meetings on first Tuesday of each month, except July and August.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA. Sec.: Chas. W. Ridinger, 410 Penn. Ave., Pittsburg. Regular meetings on third Tuesday of each month.

FRANKLIN INSTITUTE. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August. General section meetings every Thursday.

HONOLULU ENGINEERING ASSOCIATION. Sec.: G. F. Bush, Honolulu, Hawaii.

IOWA RAILWAY CLUB. Sec.: P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

LOUISIANA ENGINEERING SOCIETY. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

MASTER CAR BUILDERS' ASSOCIATION. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 22-24, Saratoga Springs.

MONTANA SOCIETY OF ENGINEERS. Sec.: Clinton H. Moore, Butte, Mont. Regular meetings on second Saturdays.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Sec.: Ernest H. Davis, 136 Liberty St., New York. Annual convention in May, at Boston.

NEW ENGLAND RAILROAD CLUB. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month, except June, July, August and September, at Pierce Hall, Copley Square.

NEW YORK ELECTRICAL SOCIETY. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays, at the American Institute, 19 W. 44th St.

NEW YORK RAILROAD CLUB. Sec.: F. M. Whyte, Grand Central Station, N. Y. City. Regular meetings on third Friday of each month, except June, July and August, at Carnegie Hall, 154 W. 57th St., New York.

NEW YORK STREET RAILWAY ASSOCIATION. Sec.: W. W. Cole, Elmira. Annual meeting, Sept., at Utica.

NORTH-WEST RAILWAY CLUB. Sec.: T. W. Flannigan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

PACIFIC COAST ELECTRICAL TRANSMISSION ASSOCIATION. Sec.: Geo. P. Low, 237 Cherry St., San Francisco. Annual convention, third Tuesday in June. Intermediate meetings subject to call.

PACIFIC COAST RAILWAY CLUB. Sec.: C. C. Borton, Oakland, Cal. Regular meetings on third Saturday of each month at San Francisco and other cities.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS. Sec.: Prof. M. Roberts, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

RAILWAY CLUB OF PITTSBURG. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg, Pa. Regular meetings on fourth Friday of each month, except June, July and August, at Hotel Henry.

RAILWAY SIGNAL ASSOCIATION. Sec.: B. B. Adams, 83 Fulton St., New York. Regular meetings on second Tuesday of January, March, May, Sept. and Nov.

RICHMOND RAILROAD CLUB. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

ROCKY MOUNTAIN RAILWAY CLUB. Sec.: M. M. Currier, Colorado City. Regular meetings on first Saturday after the 15th of each month, at Union Depot, Denver.

ST. LOUIS RAILWAY CLUB. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

SOCIETY OF CHEMICAL INDUSTRY, NEW YORK SECTION. Sec.: H. Schweitzer, 40 Stone St. Meetings on third Friday after the first Monday of each month, at Chemists' Club, 108 W. 55th St.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov., at Atlanta.

TECHNICAL SOCIETY OF THE PACIFIC COAST. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

TEXAS RAILWAY CLUB. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

WESTERN RAILWAY CLUB. Sec.: Jos. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, except June, July and August, Auditorium Hotel, Chicago.

WESTERN SOCIETY OF ENGINEERS. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month, except July and August.

Personal.

—Mr. Henry Maurer, senior member of the firm of Henry Maurer & Son, and founder of the town of Maurer, N. J., died recently at his residence, No. 143 West 79th St., New York, from acute peritonitis. He was born in Germany in 1830 and came to this country about fifty-four years ago. He started in business as a manufacturer in 1856, and in 1875 purchased the property on which the town of Maurer, N. J., was built. He built and supported churches, school houses and other educational institutions and gave liberally to charity. He left a widow, three sons and four daughters.

—Mr. Jeremiah M. Allen, president of the Hartford Steam Boiler Inspection and Insurance Company, died at his residence in Hartford recently. Mr. Allen was born in Enfield in 1833. He was widely known in insurance circles, and was a member of various scientific and historical societies.

—Mr. David Townsend, consulting and mechanical engineer, of Philadelphia, has brought out a convenient table of the weights of cast-iron cylinders one inch long and ranging in diameter from ⅛ inch to 60 inches.

—Mr. Irving H. Reynolds, formerly with the Allis-Chalmers Company, and for many years in charge of their Pumping Engine Department, has accepted a position with the William Tod Company, of Youngstown,

O., as consulting engineer, and is in charge of the department devoted to the building of large high-duty crank and fly-wheel pumps.

—Mr. Arthur J. Herschmann, M. E., has opened an office at 45 Broadway, New York, as a consulting engineer. He will make a specialty of heating, lighting and ventilating plants, their installation and supervision, and will be glad to be consulted by persons desirous of effecting improvement or economies in such plants. He will also represent the Commercial Automobile Company, Incorporated, which concern is to work the American patents on the Herschmann system of steam trucks.

—Mr. N. S. Braden, formerly manager of the Westinghouse Electric & Manufacturing Company's district office at Cleveland, has been appointed sales manager of the new Canadian Westinghouse Company, Ltd., and assumed the duties of that office on January 1, 1904. Mr. Braden succeeds the late Thomas C. Frenyear, who died on December 10th of last year. Mr. Frenyear's office was at Toronto, but Mr. Braden will make his headquarters at Hamilton, Ontario.

—Mr. H. M. Deavitt, analytical and consulting chemist and assayer, with a large practice in Chicago, has taken the manage ment of the Chicago office of the Engineering Co., of America, 159 LaSalle St., with which office Mr. Ellis C. Spoker, the expert in cement plants, has also become associated. Mr. Edward Everett, civil engineer, who has specialized in railroad work, and who made the survey for one of the Hudson River tunnels, has become connected with the Engineering Co. of America's New York office, 74 Broadway.

—Mr. W. S. Montgomery, who has for the past five years been connected with the Conover Condenser Manufacturing Company, of Jersey City, as their secretary and sales manager, severed his connection with that company on January 1, 1904, to assume the management of the Payne Engineering Company, of New York City, which are the selling agents of the Payne Company, of Elmira, N. Y., builders of simple and compound automatic engines. On the same date the Payne Engineering Company removed to new offices in the Havemeyer Building, No. 26 Cortlandt St.

Industrial Notes.

—The Loomis-Pettibone Gas Machinery Company, after the recent increase in capital, has now been merged with The Holthoff Machinery Co., of Milwaukee, Wis., under the new corporate name of Power and Mining Machinery Company, with head offices at 52 and 54 William St., New York. The combined companies are making extensive improvements and additions to their Milwaukee plant to meet the increasing demand for the American Crossley gas engines, Loomis-Pettibone gas apparatus, and Holthoff mining machinery.

—The Lunkenheimer Company, of Cincinnati, the makers of superior brass and iron steam specialties, owing to the unprecedented and growing demand for their products, have again greatly increased their facilities, and are now in position to guarantee reasonably prompt shipments. Their foreign branches report an increasing export demand for their goods, and they will shortly place some new specialties upon the market which will be contained in a very complete catalogue to be issued in the course of a few months.

—The Pneumatic Tool Department of the Ingersoll-Sergeant Drill Co., of 26 Cortlandt St., New York, has just issued a calendar of novel and artistic design: It pictures a workman operating a Haeseler pneumatic hammer on a skyscraper, while a colored reproduction of an "axial" valve, which is a very important feature of the Haeseler-Ingersoll hammer, rotates on its axis at the middle of the calendar and points to the days of the month which are shown below.

—Warren Brothers Company, the makers of the bitulithic pavement, have been awarded the contract for the paving of West 72nd Street, New York, which is a fine boulevard connecting Central Park and Riverside Drive. The Park Department made a wise choice in selecting bitulithic pavement, which is very durable and at the same time affords as good a foothold as macadam.

—The General Electric Company, through its Incandescent Lamp Sales Department, at Harrison, N. J., has issued a handsome wall circular for use in ordering lamps. This circular contains full-size illustrations of the company's standard incandescent lamps and of many of its special lamps, among the latter being turn-down night lamps, re-

flector lamps, round-bulb lamps, stereopticon lamps, resistance lamps, candelabra and sign lamps, examination lamps for storage batteries, and other styles.

—Messrs. Woolston and Brew, mechanical engineers, have established salesrooms and a storage depôt for automobiles at 152 West 56th St., New York, where they will care for vehicles and keep them in repair. They have also secured the agencies for the Thomas triple-vertical-cylinder, 24-horsepower, gasoline touring car and the Stevens-Duryea gasoline runabout.

—The stockholders of The Otto Gas Engine Works, of Philadelphia, have decided to increase the capital of the corporation from $600,000 to $2,500,000, and build a large, new plant just as soon as the management can find a site suitable for the purpose. Large gas engines, producer gas plants, launches and marine engines, gasoline hoists, compressors and other adaptations of the gas engine, will be built promptly at the new plant. A suitable site must contain not less than thirty acres, must be located on a good water front and must have good railroad facilities.

—The 100th anniversary of the exploration of the Oregon country by Captains Meriwether Lewis and William Clark, of the United States Army, will be celebrated by an international exposition, to be held at Portland, Oregon, in 1905.

—Owing to a confusion of names, some people have been under the impression that the Berlin Construction Company, of Berlin, Conn., is going out of business. This is most emphatically not the case, as the above-mentioned company, which during the past three years, has taken and completed contracts for bridges, buildings and structural steel work amounting to millions of dollars, is rapidly increasing its business and is in most active operation.

—An important export order has just been closed with the Manila Construction Company, an American corporation conducting operations in the city of Manila, P. I., for a complete power equipment for the city traction system. The order was secured through Westinghouse, Church, Kerr & Company, and comprises the following machinery: 3 750-kilowatt Westinghouse turbo-generator units; 2 compound engine exciter units; 1 motor-driven exciter unit; 3 500-kilowatt rotary converters; 1 300-kilowatt rotary converter; 4 250-kilo- 1 300-kilowatt rotary converters; 4 250-kilowatt oil-insulated transformers; a complete switchboard; 1 series booster, mounted on the extended shaft of one of the rotary converters. The car equipments will comprise ninety double No. 68 C outfits, and ten double No. 56 outfits, using standard Westinghouse controllers.

—One of the features of the new plant of the B. F. Sturtevant Co., at Hyde Park, Mass., peculiarly indicative of the permanent character of the new works now under construction, is the steam tunnel 4½ feet in width, and 6½ feet high, extending from the power plant to the most remote part of the manufacturing buildings, a total distance of about 800 feet. This tunnel, which is of concrete construction, will not only accommodate all of the steam piping, but also the electric wires for power, light, telephone, standard time clock, and other service, together with oil, hot water and other pipes for general distribution to the various buildings of the plant. None of these features of the equipment will be carried above ground at any outdoor point. While the expense of such an installation is necessarily large, the convenience of access for changes and repairs will in the future much more than offset any fixed charges thereon.

—A material for preventing loss by fire and danger to life from the short-circuiting of high voltage electrical wires, for which the trade mark "Niagrite" has been adopted, is being placed on the market by the H. W. Johns-Manville Co. "Niagrite" is furnished in strips of several widths from 3 inches to 26 inches and is held in place by asbestos fire-proof glue, thus protecting the cables from external fire and confining the internal fire. The material presents a very neat and permanent finish, and is not affected by atmospheric conditions. It has been adopted by the Niagara Falls Power Co., The Buffalo Street Railroad Co., the International Power Co., The Edison (New York) Co., and other prominent and important electrical plants. Full information can be obtained from the Asbestos Department of the H. W. Johns-Manville Co., 100 William St., New York.

—The Ross Valve Co., of Troy, N. Y., are sending their friends an attractive and

convenient desk calendar, consisting of a leather case which holds cards for the different months.

—The Eagle Oil and Supply Co., of Boston, have issued a calendar which contains some handsome pictures, reproduced from photographs and paintings, and which they will send to any address upon receipt of 10 cents in stamps.

—The Foundrymen's Associations of the country are arranging to have a special building at the St. Louis World's Fair, which will serve as a headquarters for foundrymen and as a place for exhibiting every class of modern foundry equipment and product. Parts of the exhibit will be operating in a way to show the public something of the methods of foundry work. Further particulars may be obtained by addressing Philadelphia Foundrymen's Association, Howard Evans, Secretary, Pier 45 North, Philadelphia, or J. A. Holmes, Chief of Mines and Metallurgy, World's Fair, St. Louis.

—The Builders' Iron Foundry and the Diamond Machine Co., of Providence, R. I., are distributing a very convenient little souvenir which combines a screw driver, an opener for light boxes and an inch scale, divided into sixteenths, attached to a key ring.

—The Ashcroft Manufacturing Co., the Consolidated Safety Valve Co., the Hancock Inspirator Co., and the Hayden & Derby Mfg. Co., have established branch offices and salesrooms at 22, 24 and 26 South Canal St., Chicago, where they will carry a full and complete line of their goods, thus enabling them to fill orders from their Western customers with promptness. These offices will be in charge of Messrs. H. S. Whitney and M. A. Hudson.

—The Buhl Malleable Co., of Detroit, the successors of the Detroit Sprocket Chain Co., will be pleased to submit estimates and furnish blue prints and specifications for the installation of elevating, conveying and power-transmitting machinery, and to quote figures for malleable and grey-iron castings and metal or wood pattern work.

—The Brown Corliss Engine Co., of Corliss, Wis., have received an order from the Passaic Steel Co., of Paterson, N. J., for a 24-inch and 48-inch by 36-inch tandem rolling-mill engine.

—The Power Installation Company, of Buffalo, of which Mr. Geo. F. Wescott is vice-president and general manager, have issued a limited edition de luxe of a book entitled "Power Problems," which shows the improvements in the several systems of power transmission, as illustrated by many plants embracing boilers, engines, dynamos, conveyors, stokers, grinding and briquetting machinery, electric motors and other appliances, which they have designed and installed.

—The West Side Branch of the Young Men's Christian Association, at 318 West 57th St., New York, is having a series of lectures given by experts on structural engineering and architecture. Admission to these lectures is by tickets, which may be had free upon application. At the evening school of the West Side Y. M. C. A. instruction is given in a long list of subjects, ranging from mathematics to music, further information about which may be had by applying at the building, or by writing to the educational director.

—A friend of Lafayette College has bought and presented to the Henry W. Oliver Chemical and Metallurgical Library of that institution all the pamphlets, about 3,000 in number, belonging to the library of the late Professor Johannes Wislicenus, of the University of Leipsic. Professor Wislicenus was a famous chemist. He was a pioneer in the study of the lactic acids and led in the work which gave to us our present knowledge of stereoisomerism. This library represents the collection of fifty years of great activity and will be a fine addition to the Oliver Library and Lafayette College.

—The lifting of a thousand-ton steel bridge to a height of twenty inches so that it will clear its old supports, its transfer upstream a distance of thirty-five feet and its final lowering to a new pivot pier ten and a half feet lower than that on which it originally rested is an engineering feat of more than ordinary importance. And when it is accomplished in a space of twelve hours, with unfavorable tides, winds and river currents, it becomes all the more remarkable. Yet this is what was performed by Chief Engineer Bush of the Lackawanna Railroad recently in transferring a new steel double-deck draw span from old to new piers across the Passaic River,

at Newark, New Jersey. The bridge in question is 220 feet long, arranged for two sets of tracks one above the other. The track elevation and track depression work which the Lackawanna Railroad is doing in territory suburban to New York City involved the movement of this bridge so that the tracks on the lower deck would be at grade with the new freight tracks, and the tracks on the upper deck with the new passenger tracks. It is a simple matter to move a bridge and raise and lower it through a small difference in elevation, but to drop it ten to twelve feet exactly on top of a pivot pier located in a strong tideway is a more troublesome operation. The secret of its successful accomplishment dates back to the early Egyptians, who lowered immense stones by allowing a column of fine sand upon which they rested to run out from underneath. But the difference between the sand device used by the Lackawanna engineers and that of the ancient Egyptians is too great for them to be considered similar save in name. Probably nothing like the huge sand bins used in this modern work was ever seen before. Four immense cylinders built on scows carried the sand, which in turn supported the plungers which held the bridge. A set of slides controlled the orifices through which the sand was allowed to run out, and so perfectly was the work performed that the bridge settled into place without so much as a scratch. In other words, the sand boxes and plungers were so constructed that the difference between the elevation of grade line of the bridge on the old location and the grade line of the bridge on the new location, amounting to ten and a half feet, was taken care of by letting out the sand in the cylinders. The variation in the height of the tides and the lifting of the bridge from its old location on to the scows, as well as the releasing of the scows from underneath the bridge in its new location, were controlled by means of water ballast, which was pumped in and out of the four scows by four centrifugal pumps having a capacity of 1,600 gallons per minute. The work was started at 4 A. M. and the bridge touched the new pivot pier at 5 P. M., completing a connection that renders possible the handling of the road's immense suburban traffic in a most satisfactory way. Many bridge engineers prophesied the failure of the undertaking, but its complete success justified the boldness of the plan and stamps it as the standard method of such operations in future.

—The Chilean Government has decided to construct a sewerage system for the capital city of Santiago, the cost of which will exceed $5,000,000, and has invited bids from contractors. The completion of the Transandine Railway, via Uspallata, is another great work of the government of Chile, for which bids must be submitted by May 1st. Further information about these great enterprises and about every branch of commercial and industrial work in Chile will be furnished by the International Agency of Industrial and Commercial Propaganda, Santiago, Chile.

Messrs. McLaughlin Brothers, whose offices are in the Land Title Building, Philadelphia, have become selling agents for the product of The Reeves Engine Co. for Southern New Jersey, Eastern Pennsylvania, Delaware, Maryland and the District of Columbia.

—An indication of the large amount of river and harbor improvement work now under way or contemplated by the United States Government is given by the fact that at present ten suction dredges are being built, two of which will be sent to the Great Lakes, two to New York Harbor, two to the Mississippi River, two to Charleston, S. C., one to Galveston, and one to Savannah, Ga. The contracts for building these vessels have been distributed to a large number of builders, possibly for the purpose of hastening their completion. Five are being constructed by the Maryland Steel Company, two by the Jas. Reilly Repair & Supply Co., and one each by the W. R. Trigg Co., the Petersburg Iron Works Co. and the New York Shipbuilding Co. The mechanical equipment of the dredges for salt-water service will include surface-condenser outfits with Blake air pumps, feed pumps, fire pumps, etc. The dredges for the Great Lakes are provided with very large Blake cross-compound, double-acting air pumps and jet condensers with the usual complement of Blake vertical duplex feed pumps, fire pumps, etc. The air pumps are of a very novel arrangement, inasmuch as it is possible to cut each pump in half and run one side entirely independent of the other.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them.
Please mention The Engineering Magazine When you write.

Advertising.

Pamphlet, entitled "Publicity," giving an interesting description of courses of instruction in the principles and practice of advertising, showcard writing and window dressing, with many illustrations. 9 by 6 in.; pp. 48. International Correspondence Schools, Scranton, Pa.

Cranes.

Cloth-bound catalogue, with descriptions and many half-tone illustrations of electric and steam locomotive cranes, steam wrecking cranes, electric traveling cranes, high-speed balanced cantilever and gantry cranes, hand traveling cranes, jib cranes, floating cranes, stationary hand bridge cranes, pillar cranes, hand truck cranes, overhead tramrail and trolley, railway transfer tables and other kinds of hoisting and handling machinery. 6 by 9 in.; pp. 261. The Brown Hoisting Machinery Co., Incorporated, Cleveland, Ohio.

Drop Forgings.

Booklet, with illustrations and descriptions of drop forgings of many kinds, and, particularly, a list of drop-forged cranks and crank shafts, in various styles and sizes. 6 by 3½ in.; pp. 39. Wyman & Gordon, Worcester, Mass.

Catalogue, with illustrations and descriptions of many styles of wrenches, pliers, ratchet drills, and a great variety of other drop forgings. 7½ by 5 in.; pp. 119. Also, catalogues devoted, respectively, to drop forgings for vehicles and automobiles; drop hammers, trimming presses and heating furnaces; and commutator segments for all standard street-railway electric motors. The Billings and Spencer Co., Hartford, Conn.

Dryers.

Catalogue D, containing a well illustrated description of drying machines for clay, rock, ores, lime, sand, furnace slag and other materials to which direct heat may be applied, and accounts of other dryers for many more kinds of material, together with records of tests, testimonials and list of users. 5¾ by 8¾ in.; pp. 28. Ruggles-Coles Engineering Co., 39 Cortlandt St., New York.

Electric Brewery.

Bulletin No. 39, with illustrations and description of the interesting electrical and mechanical equipment of the Orange Brewery, where the power for many of the processes is supplied by electric motors. 10 by 7½ in.; pp. 8. Crocker-Wheeler Co., Ampere, N. J.

Electric Rock Drill.

Catalogue No. 1, with illustration and description of the Deitz electric rock drill, in which the piston is released from the driving mechanism before the rock is struck, thus protecting the working parts from any harmful shocks. The whole drill is of simple and substantial design and is made of the best materials. 8½ by 6 in.; pp. 11. The Deitz Drill and Machinery Co., Denver, Colo.

Filtration.

Pamphlet, containing a brief historical sketch of the Alexandria (Egypt) Water Works, and a report on the results of a series of successful experiments which were made there with a Jewell gravity filter plant, with illustrations, diagrams and tables. 10¾ by 8¼ in.; pp. 31. The New York Continental Jewell Filtration Co., 15 Broad St., New York.

Foundry.

Bulletin No. 54, containing a well illustrated and interesting description of the new foundry and pattern departments of the B. F. Sturtevant Co., at Hyde Park, Mass., and their modern equipment for the manufacture of fans, blowers, mechanical-draft apparatus, and other machinery and industrial appliances. 9 by 6½ in.; pp. 16. B. F. Sturtevant Co., Boston, Mass.

Friction Clutches.

Booklet C, with illustrations and description of the Johnson friction clutch, both single and double, for gas engines, countershafts and machines in general. 6½ by 3½ in.; pp. 11. Also, folders devoted to these clutches, which have but few parts and are very compact. The Carlyle Johnson Machine Co., Hartford, Conn.

Gas Producers.

Pamphlet, entitled "Gas for Furnace Work," containing an illustrated account, abstracted from the *Engineering Record*, of a model Loomis-Fettibone gas plant for supplying direct-fired furnaces for forging, for heating rivets, angles and plates, and for other uses, at the works of the Pennsylvania Steel Company, Steelton, Pa. 10 by 7 in.; pp. 8. Power and Mining Machinery Co. (formerly Loomis-Pettibone Gas Machinery Co.), 52 William St., New York.

Graphite.

A pamphlet giving a tastefully illustrated account of some of the uses to which graphite may be put. Among the subjects are: Pencils; crucibles; graphite in the foundry; lubrication for automobiles and bicycles, guns, power launches, etc.; "pot-lead" for yacht bottoms; graphite in electrotyping and other electrical work; stove polish and stove cement; belt dressing; graphite paint; and pipe-joint compound. 8½ by 4 in.; pp. 24. The Joseph Dixon Crucible Co., Jersey City, N. J.

Hack Saws.

Catalogue No. 10, containing illustrations, descriptions and prices of hack saws with flexible-back blades, flexible-back band saws, band-saw frames, jig-sawing machines for cutting steel dies, patterns, etc., non-friction band-saw guides, and other metal-sawing machinery and appliances. 9 by 6 in.; pp. 16. The Henry G. Thompson & Son Co., New Haven, Conn.

Hot-Blast Smelting.

Pamphlet entitled "The Hot-Blast Stove and Its Application to Copper and Pyritic Smelting," and containing a collection of papers on the utility and great importance of a heated air blast in smelting all kinds of ores, with many illustrations. 9¼ by 6½ in.; pp. 64. The Colorado Iron Works Co., Denver.

Jacks.

Catalogue E, with illustrations, descriptions and prices of Barrett patent compound-lever and differential-screw jacks for cars and automobiles, raising track, automatic lowering, forcing pipe horizontally through the ground, wrenching and unwrenching oil-well tools, lifting and removing motor armatures, moving loads horizontally, and for other kinds of work. 8¾ by 5¾ in.; pp. 54. The Duff Manufacturing Co., Pittsburg, Pa.

Lathes.

Catalogue (Issue No. 23), containing half-tone illustrations and comprehensive descriptions of various styles of metal-working lathes, adapted to the use of the modern high-speed steel tools, their parts and attachments, together with telegraphic code. 6 by 9 in.; pp. 68. The Bradford Machine Tool Co., Cincinnati, Ohio.

Locomotives.

Cloth-bound book, with illustrations and descriptions of light locomotives, of both broad and narrow gauges, for logging, plantation, contractors' and every other variety of industrial and special service. These locomotives will burn wood, coke or bituminous coal, and can be adapted to use petroleum as fuel. The book contains also useful tables and information about locomotives and railways. 6 by 9 in.; pp. 72. Baldwin Locomotive Works, Philadelphia, Pa.

Logging Engines.

Catalogue L-1, containing illustrations and descriptions of logging engines, including yarding engines and road engines, the Fouts grip wheel and traction engine, log slide engines, towing engines, friction devices, logging trucks, road and yarding spools, fairleaders, wire rope, and other kinds of logging machinery and tools. 7½ by 9¾ in.; pp. 47. Willamette Iron & Steel Works, Portland, Oregon.

Magnetic Separator.

Pamphlet, describing the Cleveland-Knowles magnetic separator, which is particularly adapted for removing the iron minerals from zinc-lead ores, and the methods of treating these ores. 8½ by 5½ in.; pp. 9. Also, catalogues devoted, respectively, to mining machinery and concentrating plants and to ammonia compressors and other refrigerating machinery. United Iron Works Co., Springfield, Missouri.

Milling Machines.

Catalogue, containing descriptions and illustrations of large milling machines and milling cutters, of new design, built in accordance with the most modern ideas, for heavy work and high speeds and consequent large output. 9 by 6 in.; pp. 22. The Hess Machine Co., Pennsylvania Building, Philadelphia.

Pipe Machinery.

Catalogue No. 16, with flexible cloth covers, containing illustrations, descriptions and prices of improved pipe-threading and cutting-off machinery, hand emery surfacers, roller cutters, "Peerless" adjusting mechanism for expanding dies, and other machines and appliances, together with useful tables and information. 9 by 6 in.; pp. 62. Bignall & Keeler Mfg. Co., Edwardsville, Ill.

Pneumatic Tubes.

Book, containing elaborate illustrations and descriptions of pneumatic tube service for transporting mail, messages, merchandise, cash and other things about cities and works and within buildings. 9¾ by 7 in.; pp. 48. American Pneumatic Service Co., Boston, Mass.

Rotary Planers.

Catalogue No. 37, with illustrations and descriptions of various styles and sizes of high-grade rotary planing machines, fixed or portable and either belt or motor driven. 9 by 6 in.; pp. 16. Newton Machine Tool Works (Incorporated), Philadelphia.

Scrapers.

Fully illustrated catalogue, with descriptions of wheeled earth scrapers, drag scrapers, elevating graders, ditchers and wagon loaders, railroad and township plows, reversible graders, dump, ore and stone cars, dump carts and wagons, and other appliances and machinery for handling earth and stone. 6¾ by 9¾ in.; pp. 96. Western Wheeled Scraper Co., Aurora, Ill.

Screens.

Catalogue No. 69, containing illustrations and descriptions of vibrating, revolving, and other styles of screens and screening plants for treating coal, coke, rock, stone, clay, ores, plaster, cement, sand and many other kinds of material. 9 by 6 in.; pp. 56. Also, catalogue No. 52, devoted to coal-washing machinery. 7 by 9 in., pp. 76. The Jeffrey Manufacturing Co., Columbus, Ohio.

Sugar Machinery.

Catalogue, with illustrations and descriptions of all kinds of machinery for the extraction and manufacturing of sugar, and a variety of other machinery, and mill, factory, plantation, railroad and steamboat supplies. 10 by 7 in.; pp. 186. John H. Murphy's Iron Works, New Orleans, La.

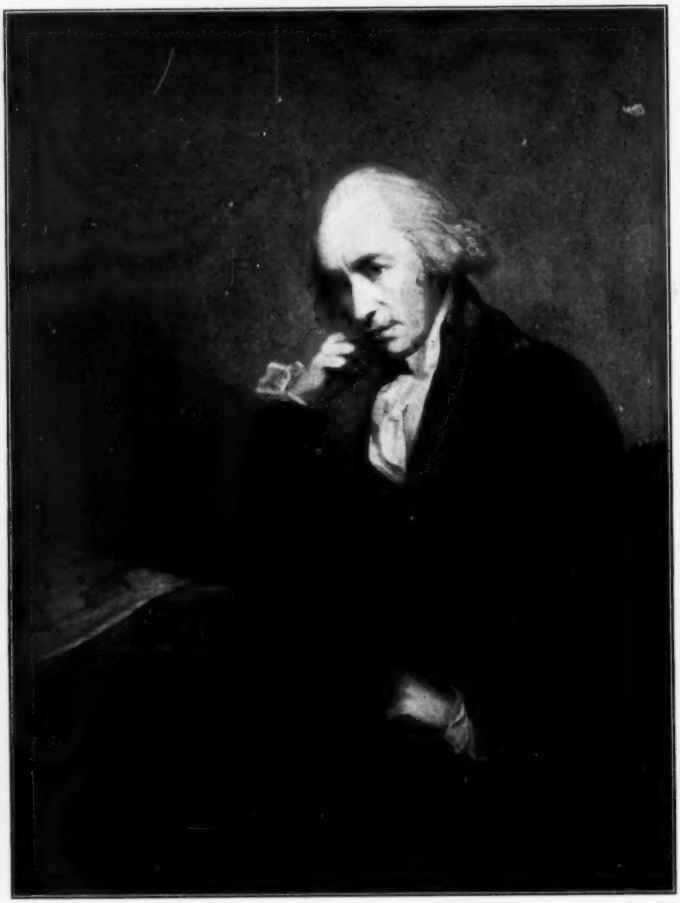
Testing Machines.

Catalogue A, containing illustrations and descriptions of Riehlé testing machines for general purposes, in capacities from 500,000 pounds down, extensometers and special appliances, torsion testing machines, dynamometers, etc. 12¾ by 9¾ in.; pp. 88. Also, catalogues B, C, D, E, F, G, H and I, devoted, respectively, to wire and cloth testing machines; chain testing machines; transverse testing machines; spring testing machines; hydraulic pumps, presses and other machinery; cement testing machines; marble machinery; and trucks and contractors' supplies. 12 by 9 in. Riehlé Bros. Testing Machine Co., Philadelphia.

THE ENGINEERING MAGAZINE.

MARCH, 1904.

LABOR SAVING BY POWER APPLICATIONS.



JAMES WATT. 1736-1819.

Portrait by de Breda, National Portrait Gallery. Copyright by Walker & Cockerell. The great engineer who, "directing the force of an original genius, early exercised in philosophical research, to the improvement of the steam engine, enlarged the resources of his country, increased the power of man, and rose to an eminent place among the most illustrious followers of science, and the real benefactors of the world."—*Lord Brougham.*